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TRANSACTIONS
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KENNETH T. MORSE
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SECTION OF GEOLOGY AND MINERALOGY

CLIMATIC INTERPRETATION OF CENOZOIC FAUNAL MIGRATIONS IN NEW ZEALAND*

By Donald F. Squires

Department of Geology and Paleontology,
The American Museum of Natural History,
New York, N. Y.

It would be a serious departure from reality to regard marine climates as stable. Fluctuating climatic conditions are as effective in the control and distribution of all marine organisms as with terrestrial animals and plants. The factors that are subject to diurnal and seasonal fluctuations differ from those that we experience in our own subaerial climate, and the organisms themselves are adapted, within limits, to these changes. The quantitative data expressing climatic variables may not seem impressive in gross aspect, but they assume the same definitive proportions as, for example, are recorded in studies of microclimates of the upper and lower surface of a leaf, which differ sufficiently to allow an insect to survive otherwise intolerable conditions.

Salinity, dissolved gases, specific gravity, pressure, and temperature are necessary factors in the consideration of marine climates. These are regulated and distributed primarily through the agency of atmospheric circulation and thus provide a direct connection between the aerial and aqueous phases. The study of past marine climates, then, is intimately related to the study of past terrestrial climates.

The location of New Zealand directly affects both its marine and terrestrial climates, and results in a diversification and in sharp demarcations in the faunas of major environments. An invisible barrier formed by the juncture of two unlike water masses separates the two islands of New Zealand nearly as effectively as a wall extending from the ocean bottom well up into the atmosphere.

Geologically, New Zealand is composed of a recurved structural arc, the backbone of which is formed by Paleozoic and lower Mesozoic sediments, in part metamorphosed, flanked by coastal areas of Tertiary rocks. This arc remained, through most of the Tertiary, as a central dividing land mass, or as a chain of islands during times of greatest submergence. Sedimentation in the geosynclinal areas on either side was great. Stratigraphic thicknesses of 60,000 feet are not uncommon. Sedimentation was often accompanied by diastrophism resulting in a stratigraphic section marked by hiatuses, reworked sediments, and transgressive sequences, all of which have made the establishment of a stratigraphic sequence difficult.

*This paper, illustrated with lantern slides, was presented at a meeting of the Section on February 6, 1956.

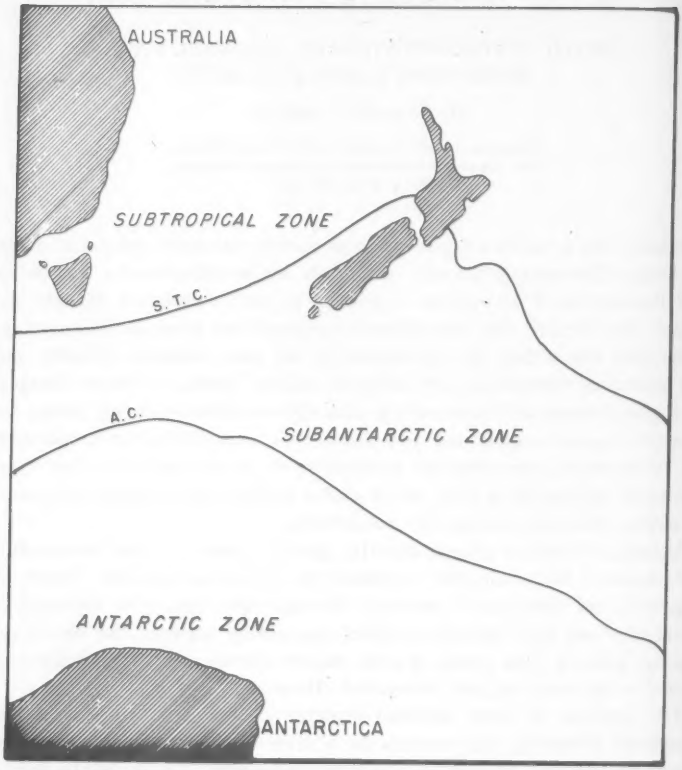

FIGURE 1. A generalized map showing the position of New Zealand in relation to Australia and Antarctica. The hydrologic boundaries of the Southern Ocean are also indicated. A. C.: Antarctic Convergence; S. T. C.: Subtropical Convergence.

One of the interesting and intriguing aspects of New Zealand structural geology is the possibility of linkages to other land masses. Several hypotheses in this connection have been advanced by structural geologists. Early workers considered a linkage through the broad shelflike extension of the southern portion of the arc to Antarctica. Far more promising are connections to the north, and three alternatives have been suggested. Marshall (1932) and others have postulated a linkage through the Tonga-Kermadec Island group with frontage on the Tonga Trench. This idea is supported by the fact that this belt is seismically active and has undergone late structural deformation. Generally accepted as more plausible is a suggestion by a second school (Suess, 1885; Benson, 1923; MacPherson, 1946) that the arc is continued through the Norfolk

Islands and New Caledonia. A recent suggestion by Hess and Maxwell (1953) has combined both of these theories by linking the northern portion of the arc with the Tonga-Kermadec groups, which faulting has separated from the Norfolk Island group and New Caledonia. Relationships with Australia have been satisfactorily determined, and the two are regarded as separate, having been divided through the Tertiary by the Tasman Sea.

Let us examine the unusual oceanographic position of New Zealand. The Southern Ocean is composed of three great water masses: the Antarctic, Subantarctic, and Subtropical waters. These three units meet in rather well-defined boundaries, termed convergences: the Subantarctic Convergence, separating the Antarctic and Subantarctic waters, and the Subtropical Convergence, the zone of juncture between the Subantarctic and Subtropical waters. A convergence is an area of downflowing of water and, consequently, the origin of a lower water mass. The northward-

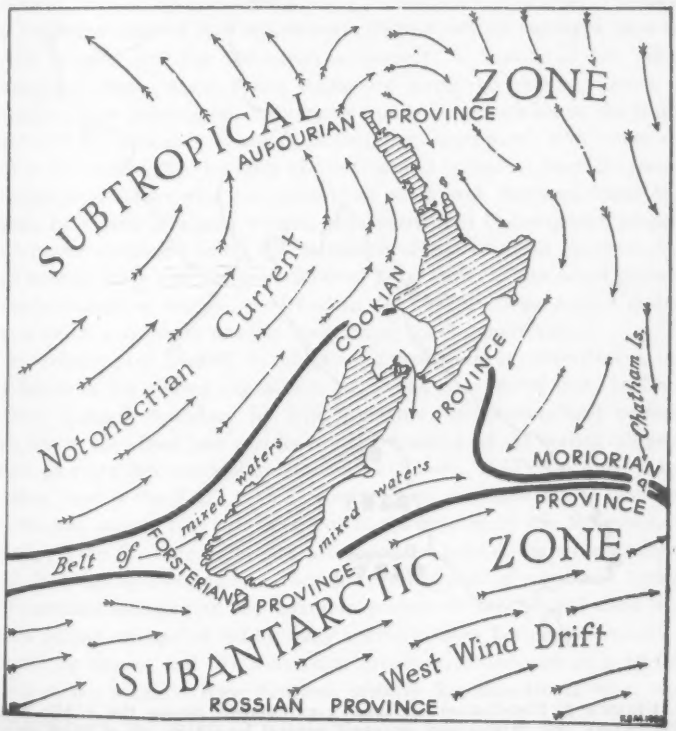

FIGURE 2. Marine faunal provinces in the New Zealand region and their relationships to the position of the Subtropical Convergence and the surface currents (after Fleming, 1944).

flowing Antarctic Intermediate water is formed at the Antarctic Convergence while, at the Subtropical Convergence, the southward-flowing return circulation of the Subantarctic water is formed. New Zealand is situated astride the Subtropical Convergence, with Cook Strait the approximate position of the boundary although, in reality, there is a zone of mixed waters along the shores of the South Island.

FIGURE 3. Distribution of some coral genera during the middle Eocene (Bortonian). One symbol may represent several localities, all of which are near the coast. Explanation of symbols: circles, *Flabellum;* triangles, *Balanophyllia;* squares, *Stephanocyathus (Odontocyathus);* solid triangles, *Caryophyllia;* inverted triangles, *Madrepora.*

Deacon (1937, 1952) has indicated the contrast of the waters on either side of the Convergence. The Subtropical waters moving southward are warm, with a temperature range of from 11.5° to 14.5° C., and a salinity of 3.49 to 3.55 per cent. The Subantarctic waters, moving northward, are cooler, 8° to 12° C., and less saline, 3.4 to 3.45 per cent. The summer difference in water temperatures on either side of the Convergence is 4 to 6 degrees, but the winter difference is less, being only 1 or 2 degrees.

Arranged stratally beneath the surface waters are several water masses that are rather sharply defined. These are: (1) the northward-flowing Antarctic Intermediate Current, which forms at the Antarctic Convergence; (2) the southward-moving "warm deep current"; and (3) the basal Antarctic Bottom Water, which moves northward. These are too deep to affect the littoral faunas, although they do provide sharply contrasted environments for deeper-water animals.

Currents act upon this broad picture and change it, particularly in the near-shore areas. Two eastward-flowing currents are prominent: the West Wind Drift, the zone of the Subantarctic Waters, which impinges only on Stewart Island; and the Notonectian Current, a branch of the South Equatorial Current, which flows southward along the eastern shores of Australia to the Subtropical Convergence and then eastward to the North Island of New Zealand, where it is deflected northward. The latter returns to the south in the vicinity of the Chatham Islands, where it causes the Subtropical Convergence to be shifted southward. Between these two currents is a zone of mixed waters, the Subtropical Convergence proper, which moves eastward under the influence of the adjacent currents and flows through Cook and Foveaux Straits. This, then, is the broad pattern of the hydrological regime, modified in details by irregularities at the shores, which may cause sharply contrasting local conditions.

The hydrological regime is of prime importance in determining the distribution of the marine organisms, for it has been noted that the Convergence forms a boundary for fish, plankton, and nonabyssal bottom-living forms. Its effect has resulted in the division of the marine biogeographic province into several subprovinces (Powell, 1937): (1) Aupourian, including most of the North Island, a subtropical province with a fauna of Kermadecian aspect that has been colonized chiefly by the Notonectian Current; (2) the Cookian or central province, the area of the mixed waters of the Subtropical Convergence, which contains mostly euryzonal forms; (3) Forsterian, comprising the southern portion of the South Island and Stewart Island, characterized by many endemic forms but predominantly a Subantarctic fauna; and (4) a Rossian province, developed only in the islands to the south of New Zealand, strictly Subantarctic in type, and lying within the belt of the Subantarctic waters.

The effect of the Subtropical Convergence cannot be overstated, and is not limited to the marine organisms, for its effects may also be noted in the avian fauna (Fleming, 1939, p. 386).

"The North Island, north of the Convergence, is inhabited by a subtropical fauna of oceanic birds not found breeding south of the Convergence...together with a more or less "zoneless" group of birds which are found on both sides of the convergence in the New Zealand region...

"The Convergence thus represents the southern breeding limit of a strong subtropical element, but it is far from being the northern limit of

FIGURE 4. Distribution of some corals during the middle Oligocene (Waitakian). One symbol may represent several localities, all of which are near the coast. Explanation of symbols: circles, several genera of *Alcyonaria;* squares, *Flabellum;* triangles, *Madrepora;* inverted triangles, *Oculina;* solid triangles, *Stephanocyathus* (*Odontocyathus*); inverted solid triangles, *Ceratotrochus.*

the subantarctic element. The belt of mixed waters south of the Convergence appears to be practically an oceanic desert, both to subtropical and subantarctic species. It is only where the influence of the pure and unmixed waters of the West Wind Drift is closely felt, as in the Foveaux Strait region, that the subantarctic element enters the avian fauna. Only members of the 'zoneless' group listed above breed in the intervening

FIGURE 5. Distribution of coral faunas during the lower Miocene (Altonian). One symbol may represent several localities, all of which are near the coast. Explanation of symbols: circles, ahermatypic corals also found in the earlier Tertiary of New Zealand; triangles, ahermatypic corals of Indo-Pacific origin introduced during the Altonian; squares, hermatypic faunule introduced during the Altonian; inverted triangles, ahermatic coral assemblage of Indo-Pacific affinities apparently unrelated to that of the Kaipara area. See text for full explanation.

area, which is then characterized by a paucity of species of breeding oceanic birds."

The following discussion of the movements of the fossil marine faunas is based upon the Foraminifera, corals, and Mollusca. I have made a study of the corals, and information on the other groups is derived from the published reports of Finlay, Fleming, and Hornibrook. There are well-documented records of the movements of the post Miocene faunas and, for that reason, these will be discussed first. The temperatures of the early Miocene seas were the highest known for the New Zealand Tertiary. During the latter part of the Miocene, a general cooling trend became well established. This is reflected in the faunas of the late Miocene and Pliocene by a general decline in the number of species, which continued until the establishment of approximately present-day conditions. However, the chilling did not occur uniformly but was accompanied by intermittent warming and cooling intervals that apparently are closely allied with periods of recurring glaciation.

The following discussion is based on C. A. Fleming's work on the Mollusca (Fleming, 1944, 1952). The period of extinction beginning in the Miocene culminated in the Pliocene (Waitotaroan)* but, apparently, even at this point, the waters were warmer than at the present. With the onset of the first glaciation, there was a northward migration of many mollusks of cold-water origin to the middle latitudes of the North Island. Except for a few eurythermal forms, these species retreated with the return of warm waters in the Pleistocene (upper Nukumaruan). The second glaciation resulted in the extinction of some warm-water genera and the establishment of a cool-water impoverished fauna, followed by a second invasion of warm-water forms. Neither of the latter movements was of the magnitude of the first.

The corals and the Foraminifera have not proved to be sufficiently delicately adjusted to react to the fluctuating conditions. The coral fauna of the post-Miocene period consisted of ahermatypic species of *Flabellum*, *Balanophyllia*, and *Caryophyllia*, forms capable of living in a broad range of temperatures and depths, and presumably able to evade warming or cooling surface waters by retreating to a greater depth.

The factors causing fluctuations in the faunas have been attributed to migrations of the Subtropical Convergence, which shifted northward with the first glaciation, and retreated to the south during interglacial periods. The conditions on either side of the Convergence are sufficiently extreme to cause extinction of all but the most vigorous of the molluscan species.

The pre-Miocene history of New Zealand is not known in detail, but all indications are that the oceanographic conditions were somewhat more uniform than those of later time. Paleocene and lower-Eocene

*New Zealand local stage names are given in parentheses.

faunas are not too well known, probably because of high rates of sedimentation and otherwise unsuitable environments. But with the middle Eocene (Bortonian), a great burst of development in the faunas is observed (Hornibrook, 1953; Fleming, 1953). A myriad of new forms among all groups appears for the first time, flourishing in the rather broad geosynclinal areas of the time. Bryozoan "reefs" prospered on the eastern coast, with "back reef" faunas of great variety. Hornibrook (1953) has suggested that tropical conditions existed during the late Eocene for, in the upper Eocene (Runungan), *Asterocyclina, Carpenteria, Asterigerina, Amphistigina, Halkyardia,* and other genera of the larger Foraminifera are represented. The lower and middle Eocene probably was not as warm, for these forms are not represented in the fauna. The absence of reef corals may indicate that marginal tropical conditions were present rather than a true tropical environment, for there is a uniformity of the coral fauna throughout New Zealand during this epoch. Species of *Balanophyllia, Discotrochus, Asterosmilia,* and *Madracis* are all similar to species living in the Eocene Gulf of Mexico and are suggestive of temperate conditions.

It is quite certain, however, that subtropical or warmer conditions were existent over New Zealand, indicating that the Subtropical Convergence lay to the south. Two possible factors may have aided in the development of this situation. If the southern extension of New Zealand (the Campbell Plateau) were sufficiently high to affect the West Wind Drift, it would tend to shift it to the south, allowing the warmer waters of the north to move southward along the eastern coast of New Zealand. However, more probable and more effective would be a general warming of the climate, which would cause a latitudinal shifting of the circulatory belts (as the seasonal movements of the horse latitudes today).

Continuing submergence reduced the central backbone to a series of small islands during the Oligocene. But warm conditions continued throughout this period, indicated by the presence of the larger Foraminifera and such Mollusca as *Glycimeris* and *Xenophora* (Fleming, 1953). Reduced rates of sedimentation permitted the appearance of many forms previously absent. Particularly notable is the development of a large alcyonarian fauna, particularly the Pennatulacea. *Graphularia, Isis; Moltkia,* and *Melitodes* are preserved in immense numbers at some horizons, and were abundant in Australia at about the same time. Related forms are found today in a belt at the equatorial margin of the subtropical zone. Faunas of the Oligocene are principally of Indo-Pacific origin, with such genera as *Caryophyllia, Stephanocyathus* (*Odontocyathus*), and *Conocyathus* present. *Notocyathus,* a peculiar Australian form, is common in the Oligocene. The faunas are not evenly distributed but are apparently segregated according to depth. Particularly notable examples are found in the Westland district, where the Paparoa geosyn-

cline was rapidly subsiding, and in the Kaipara Harbor area, a tectonic trench where only those species capable of living in deeper water existed. On the other hand, shallow embayments are known in the Middle Oligocene (Duntroonian), in which immense numbers of the fan coral *Flabellum pavoninum circulare* flourished.

Beginning with the Miocene (Altonian), vast changes are noted in the faunas. These changes are particularly striking because an upper Oligocene general regression resulted in a destruction of much of the record. The orogenic activity that caused this regression uplifted the central belt of mountains and separated the eastern and western seaways. It is possible that the effect of the movement was felt northward along the extension of the arc to the Norfolk Islands and New Caledonia. It is rather difficult to conceive of this northern linkage as a land bridge because much of it now lies at a depth of 2000 meters or more.

In the southern portions of New Zealand, many elements of the Oligocene fauna lived on in the Miocene. These forms, of subtropical nature, were living under much the same conditions as before. Essentially the same fauna as that of the South Island was found in the Kaipara Harbor area, but occurring with it there are ahermatypic corals of Indo-Pacific origin, corals associated with reefs but characteristic of deeper water than reef corals. *Flabellum apertum deludens*, *Oculina* sp., and *Caryophyllia japonica* are examples. Near the surface in the Kaipara Harbor area were shallow platforms on which flourished a fauna of hermatypic corals, including *Porites*, *Stylophora*, *Leptastrea*, *Plesiastrea*, *Turbinaria*, *Lobophyllia*, and *Alveopora*. Although reef structures are not known, these corals were capable of forming them. All of these forms are specifically identical with Miocene Indo-Pacific reef faunas to the north. These hermatypic corals are not found in place, but are associated with the deeper-water fauna and are usually worn. Sedimentary structures are indicative of slumping and possibly of turbidity current action, and the volcanic-tectonic framework of the area is such that physical requisites for this type of action were present.

A third area, the Poverty Bay-Gisborne district, on the eastern coast of the North Island, has an even different fauna, with *Dendrophyllia boschmai* and *Flabellum pavoninum pavoninum* present, all possibly indicative of rather deep waters. The poorly developed fauna may be in part a reflection of the depth and of the fact that the area was receiving quantities of sediments. However, the Indo-Pacific origin of these forms is significant.

Interpretation of these three areas as separate provinces is based only upon coral evidence, as the recognition of the division among the molluscan and foraminiferal faunas is in question. During the orogenic episode in the late Oligocene, the northward connections may have been uplifted sufficiently to deflect the South Equatorial Current southward

directly to the North Island. This would have directed warm waters into the Kaipara Harbor area, possibly enabling the hermatypic corals to obtain a foothold. Marginal conditions were probably present, precluding the development of extensive reefs, and the Tasman Sea was possibly a semi-isolated basin, probably with a counterclockwise circulation. It is unfortunate that little is known of the lower-Miocene corals of this area.

To the south, the Subtropical Current flowing eastward along the southern coast of Australia would, in part, have entered the Tasman Sea, but the main stream would have been deflected to the south as it passed South Island by the Campbell Plateau. This would have left the eastern shore of the North Island without primary circulation, a condition resulting in one of two possible circulation patterns. A counterclockwise gyral may have developed in the northward-moving southern current, thus introducing subtropical conditions into the Hawkes Bay district. The area would have been colonized from the northern equatorial current, but inhabited only by species capable of surviving under the greater temperature range present under these circumstances. A second hypothesis necessitates the upwelling of waters along the eastern shore to form a drift paralleling the equatorial current flowing to the southeast. The latter suggestion has merits, in that the temperatures prevailing in the area of upwelling would be sufficiently low to develop a deeper-water fauna such as that found there. Hydrologically, it is more difficult to develop, particularly because of the location on the eastern coast.

With the close of the Altonian, the hermatypic corals disappeared, and the Indo-Pacific ahermatypic elements mixed with the earlier faunas, probably due to a breakdown of the northern barrier and a return to subtropical conditions.

The general picture is, then, one of increasingly warmer temperatures through the early Tertiary, culminating in the Miocene, when marginal tropical or warmer conditions were present in portions of New Zealand. Following this peak, there was a general return to subtropical environments, interrupted by fluctuations to subantarctic climates during the various glacial stages. The warming trends approached tropical conditions, but the tropical faunas could not have been introduced without the intervention of changing current patterns.

The local climatic sequence derived from the study of marine faunas is substantially in agreement with that of terrestrial faunas and floras. One apparent exception is the case of the penguins, whose Miocene distribution was very similar to that of the Recent. The information has interesting corollaries with the general climatic picture of the world, for there are many indications that the equatorial climatic zones widened during the Tertiary, culminating in the Miocene, when reef corals and reefs extended to latitudes as high as 50° on either side of the equator.

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SECTION OF PHYSICS AND CHEMISTRY

THE CHEMISTRY OF POISON IVY*

By Charles R. Dawson

Department of Chemistry, Columbia University, New York, N. Y.

Poison ivy has been a problem to Americans ever since the days of the early settlers. Captain John Smith was one of the first to describe the plant, and he also made records of its effect on the human skin.[1] The North American Indians had trouble with poison ivy, for they likewise suffered the painful irritation, inflammation, and blistering of the skin that follows contact with most parts of the plant. Today it is estimated that more than one million Americans who take to the woods, hills, and fields each year in search of pleasure find the miseries of poison ivy instead.

The hands shown in FIGURE 1 are those of a young lady several days after she had picked some poison ivy.

When this type of condition exists over an extended area of the body, the individual involved is more than just uncomfortable—he or she is very *ill*. Numerous deaths have been recorded in the medical literature as arising from complications resulting from severe ivy poisoning.

There are three varieties of the species *Rhus toxicodendron* that are responsible for the majority of poison-ivylike dermatitis cases in this country. They are: poison ivy (*Rhus toxicodendron radicans*); poison oak (*R. toxicodendron diversilobum*); and poison sumac (*R. toxicodendron vernix*). All three belong to the Anacardiacea family of plants, members of which are found in many parts of the world. Many members of this family are "poisonous" in the sense that their saps produce a poison-ivylike dermatitis following contact with the skin.

Two other interesting members of this family are the lac tree (*Rhus vernicifiua*), found in Japan, China, and Indochina; and the cashew nut tree (*Anacardium occidentale*), found in India, the East Indies, Africa, Central and South America.

Poison ivy is particularly abundant in the northeastern quadrant of the United States and southeastern Canada. It is usually encountered as a shrubby vine that grows best in places that lend support to the vine. The vine is covered with hairlike rootlets that enable it to cling to any convenient support, and it is often found growing up fences, stone walls, buildings, and trees (FIGURE 2).

Poison ivy is readily recognized in the spring and early summer months by its characteristic smooth, light green leaves arranged in a cluster of three leaflets per stem. It has inconspicuous yellowish-green flowers

*This paper was presented at a meeting of the Section on February 7, 1956.

that are followed in the late summer and autumn by a cream-colored fruit about the size of a cherry stone. This fruit, arranged in small clusters, often remains on the plant throughout the winter.

Poison oak, most commonly encountered in the western United States and northern Mexico, is similar to poison ivy in many respects. It is believed that the differences between the two may be due only to differences in geographic conditions. Poison oak commonly grows without support, as a bush, and it gets its name because its three leaves per stem are shaped like oak leaves. It is reported that poison ivy or poison oak has been found in every state of the Union with the possible exception of Nevada.[2]

The poison sumac bush or tree, commonly found in the swamp regions of the southern and eastern United States, has 7 to 14 leaves on each stalk, and the fruit is similar to that of poison ivy and poison oak.

When the bark or leaves of any of these plants are cut or injured, an oily fluid or sap exudes that rapidly darkens on exposure to air, and the injury becomes covered with a hard, dark resinlike covering. Contact

FIGURE 1. Poison ivy dermatitis, female hands.

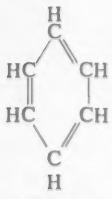
FIGURE 2. Poison ivy growing up tree.

with the sap or the resin, in the case of previously sensitized individuals, produces the typical clinical symptoms of poison ivy dermatitis.

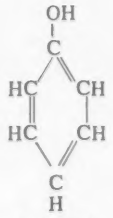
Because of the irritating and most annoying impact that it has each year on the American public, poison ivy is probably the most widely known of all North American plants.[3] Consequently there has long been an interest in determining the chemical structure of its active principle. The first chemical investigation was made by Khittel,[4] just a little less than 100 years ago; and a little over 20 years ago the carbon skeleton of the active principle became known as the result of the work of Hill[5] and his students at Wesleyan University, Middletown, Conn. The complete structural features of the active principle have recently been elaborated in our laboratories at Columbia University.[6]

During the period 1906 to 1922, Majima and his associates in Japan made an exhaustive investigation of the chemical nature of the vesicant material in the sap of the Japanese lac tree. They extracted from the sap a highly active yellow oil which was unsaturated and gave typical catechol reactions. They called the yellow oil "urushiol," since it had been obtained from kiurushi, the Japanese name for the sap.[7]

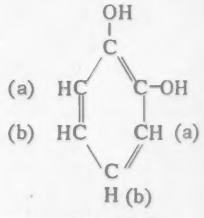
The structure of catechol has long been known. It is a vicinal dihydroxy derivative of benzene, and it is closely related to phenol, or carbolic acid.



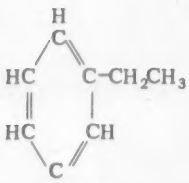
Benzene
C_6H_6



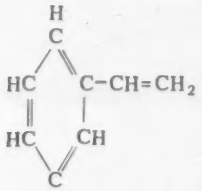
Phenol
(carbolic acid)
C_6H_6O



Catechol
$C_6H_6O_2$



Ethyl benzene



Styrene

When one of the hydrogen atoms of the benzene ring is replaced by a

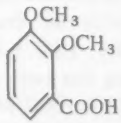
string of carbon atoms, the noncyclic portion of the molecule is referred to as a side chain. When the side chain contains less than two hydrogen atoms per carbon atom, it is said to be unsaturated. Thus ethyl benzene has a saturated side chain of two carbon atoms, and styrene has a two-carbon side chain that is unsaturated. Olefinic or alkenyl side chains (those possessing at least one double bond) are much more reactive chemically than saturated side chains. Thus styrene undergoes many chemical reactions, notably polymerization reactions, not exhibited by ethyl benzene.

It can be seen that on the catechol ring there are two positions [(a) and (b)] available for carrying a side chain. Majima showed that the unsaturated properties of urushiol were due to an olefinic side chain located in the 3-position of catechol [position (a)]. He prepared the dimethyl ether of urushiol and showed that on oxidation it was converted into the known compound, *o*-veratric acid.

Urushiol dimethyl ether —oxidation→ *o*-Veratric Acid

Colorless liquid

B.P. 190-195°
0.6 mm.



Majima found that the unsaturation of urushiol was equivalent to two olefinic bonds. That is, on catalytic hydrogenation, the toxic yellow oil absorbed two moles of hydrogen and was converted into a crystalline solid that he called "hydrourushiol." He synthesized the dimethyl ether of hydrourushiol, using starting materials of known structure. In this way he proved that the carbon skeleton of hydrourushiol, and therefore of urushiol, was that of a catechol carrying a side chain of 15 carbon atoms in the 3-position. His method of synthesis established that the 15 carbons were in a normal (nonbranched) configuration.

Majima's attempts to locate the positions of the two olefinic bonds in the side chain of urushiol led him to conclude that the toxic oil was a mixture made up of a small amount of hydrourushiol dissolved in three different olefins having the same carbon skeleton.[8] Although he could not separate the mixture, and although his proposed structures for the olefins have since been found to be incorrect in two cases,[9] Majima's work laid the foundation for our present understanding of the chemistry of several naturally occurring alkenyl phenols, including the toxic principle of poison ivy.

In 1921, McNair reported that the active principle of the poison oak in the western United States was a catechol compound possessing an unsaturated side chain. He called the active principle "lobinol" but did not locate the position of the side chain or establish its olefinic structure.[10]

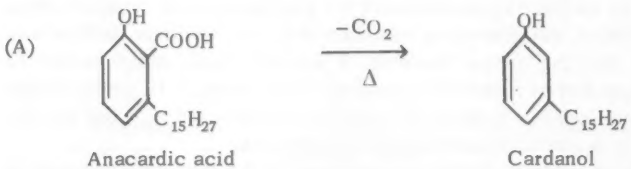
In 1934, Hill and his students at Wesleyan University[5] recognized that the yellow oil that they obtained from poison ivy bark by alcohol and xylene extraction was very similar in its toxic and chemical properties to the Japanese lac urushiol described by Majima. They hydrogenated the poison ivy oil and showed that the product was hydrourushiol, thereby establishing the skeletal structure of the poison ivy principle. The melting points of the hydrogenated material and of three different derivatives were the same as those derived from Japanese lac (TABLE 1).

Hill's work led to the widespread impression that the poison ivy principle and Japanese lac urushiol were identical. Such a conclusion, however, is not justified on the basis of his results, which established only the identity of the hydrogenated forms of the two oils.

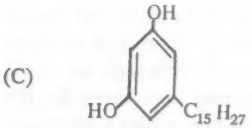
Recent work at Columbia University has shown that the poison ivy principle and the lac urushiol *are not identical.*[6,9] They are significantly different in the structural features responsible for much of their chemical reactivity, *i.e.*, they differ in their olefinic structure and composition.

During the past war we had an opportunity at Columbia University to work for several years on the structures of the alkenyl phenols present in cashew-nutshell liquid.[11-15] The oil in the shell of the nut is almost completely phenolic in composition and is composed of the following three phenols.

CASHEW-NUTSHELL LIQUID



Anacardic acid — Cardanol



Cardol

Solvent extracted oil = mainly (A) + (C).

Commercial nutshell liquid = mainly (B) + (C).

The commercial process for obtaining the nutshell liquid involves high temperatures, and most of the anacardic acid component is decarboxylated. Large amounts of the nutshell liquid are brought into this country annually from India, Africa, and Brazil for the manufacture of phenol-formaldehyde-type resins. These resins have good electrical insulation and abrasive properties. They are used in automobile brake linings and

TABLE 1

COMPARISON OF JAPANESE LAC AND POISON IVY URUSHIOL

	Lac–Majima			Poison ivy–Hill		
	State	*b.p. or m.p.*	*Tox.*	*State*	*b.p. or m.p.*	*Tox.*
Urushiol	Colorless oil	b. 210° (0.6 mm.)	Very	Yellow oil	b. 210° (0.5 mm.)	Very
Urushiol dimethyl ether	Colorless oil	b. 195° (0.6 mm.)	Sl.	Yellow oil	b. 208° (1.2 mm.)	None
Hydrourushiol	Needles	m. 58-59°	Toxic	Needles	m. 58-59°	Toxic
Hydrourushiol dimethyl ether	Prisms	m. 36-37°	None	Prisms	m. 36-37°	None
Hydrourushiol diacetate	Plates	m. 50-51°	. . .	Rhomb.	m. 50-51°	. . .
Hydrourushiol dibenzoate	Needles	m. 59-60°	. . .	Needles	m. 59-60°	. . .

during the war, they were used in the insulation of fighter aircraft and United States Signal Corps equipment.

Periodically the factory personnel, or the stevedores handling the drums of cashew-nutshell liquid on the docks, or an airplane mechanic would come down with a mysterious case of what looked like poison ivy dermatitis. Our investigations revealed that the resorcinol component, cardol, was the source of the trouble.[12] Fortunately it is the minor component of the nutshell liquid, and methods were developed to remove most of it from the raw nutshell liquid.

Of great interest to us during these studies on cashew-nutshell liquid was the fact that in cardanol, the monophenolic component, we had available in large amounts a naturally occurring alkenyl phenol possessing a $C_{15}H_{27}$ side chain apparently present in the poison ivy principle. In other words, it seemed likely that we could use cardanol as a model compound for exploring ways to complete the structural identification of the poison ivy principle.

Our early experiments with the methyl ether of cardanol convinced us that although it had an unsaturation equivalent to about two olefinic bonds (corresponding to $C_{15}H_{27}$), it was actually hetero-olefinic in make-up,[14] *i.e.*, it was a mixture of olefins so closely related that usual methods of separation were unsuccessful. Finally, Symes found that methyl cardanol could be cleanly separated into a saturated, mono-olefinic, diolefinic, and triolefinic component by means of chromatography on activated alumina. The refractive indices of the chromatographic fractions showed a parallel increase with increase in double bond value—as determined by catalytic hydrogenation. The results of a typical experiment are shown in FIGURE 3.

In this way chromatographically pure samples of the mono-olefinic, diolefinic, and triolefinic components of methyl cardanol were obtained,

and their structures determined by ozonolysis and oxidative degradations.[16] In a similar manner, the olefinic make-up and structure of dimethyl cardol was elaborated.[17]

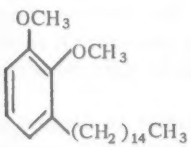
The experience gained and the techniques developed using the abundantly available alkenyl phenols of cashew-nutshell liquid made possible and attractive a reinvestigation of the olefinic character of the poison ivy principle. It was now apparent that work with the dimethyl ether of the poison ivy "urushiol" rather than the free catechol, was advisable. We knew that the dimethyl ether would be chemically more stable than the free catechol form, would move better on the chromatographic column, and would be much less hazardous to handle, since methylation renders these alkenyl phenols essentially nonallergenic (nontoxic). The method of obtaining the dimethyl ether is outlined below.

Poison ivy leaves and twigs —(Extract: Alcohol, etc.)→ Crude "urushiol"

Crude "urushiol" —(Methylate Na + CH_3I; Saponify)→ Crude dimethyl ether

Crude dimethyl ether —(Distill: 170–180° (0.5 mm.))→ Dimethyl "urushiol"
n_D^{25} 1.5032
D. B. = 2.0

Dimethyl "urushiol" —($2H_2$, Pd-C)→ 3-Pentadecylveratrole



Dimethylhydrourushiol
m.p. 35.5–36.5°

The hydrogenation of the dimethyl "urushiol" was used as a test of purity. Whenever nonurushiol contaminants were present the hydrogenated product, 3-pentadecyl veratrole was also contaminated and consequently did not have a sharp melting point. The amount of hydrogen absorbed would also be incorrect.

When the pure dimethyl "urushiol" was chromatographed on a column of activated alumina, it quickly became apparent that it was not a homogeneous diolefin. The fractions of oily liquid obtained from the column showed a parallel increase in refractive index and double bond value very similar to that observed earlier with the alkenyl phenols of cashew-nutshell liquid. Fractions of similar refractive index were combined and rechromatographed. In this way (see below) the poison ivy principle, in its methylated form, was separated into four components.[6] No fraction with a double bond value exceeding 3.0 was obtained from any of the chromatograms.

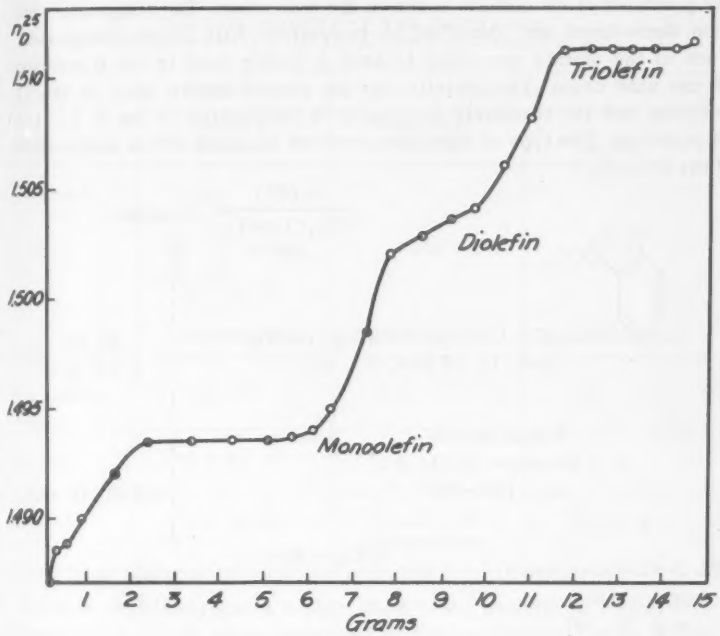


FIGURE 3. Chromatogram of methylcardanol on alumina.

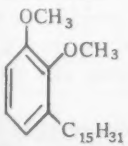
DIMETHYL "URUSHIOL"

n_D^{25} 1.5032

Ligroin soln., chromatography on alumina, develop, extrude, section, elute with Et_2O
Combine and repeat

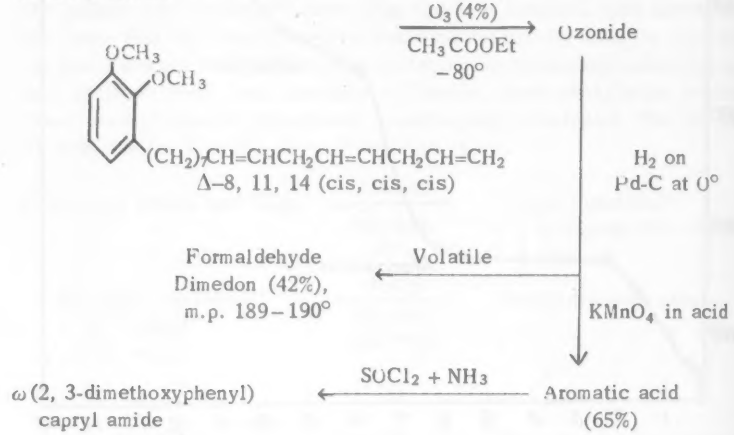
Sat. Comp.	Mono-olefin	Diolefin	Triolefin
m.p. 35.5–36.5	n_D^{25} 1.4932	n_D^{25} 1.5030	n_D^{25} 1.5160
	H_2	$2H_2$	$3H_2$

Pd-C



The structures of the three olefinic components were established by classical methods of oxidative degradation. That is, each of the pure

components was subjected to ozonolysis, *etc.*, and thereby fragmented at the positions of its olefinic bonds in the side chain. The fragments were then derivatized and identified by comparison with known compounds. Each of the olefins was found to have a double bond in the 8 position of the side chain. The diolefin has its second double bond in the 11 position, and the triolefinic component is unsaturated in the 8, 11, and 14 positions. The type of chemistry involved is shown below in the case of the triolefin.[6]



The 11 position of the middle double bond of the triolefin was established when the ultraviolet absorption spectra showed the absence of a conjugated olefinic system. That is, the four components had essentially the same ultraviolet absorption curve, which would not be the case if either the diolefinic or the triolefinic component were conjugated (contained a –CH=CH–CH=CH– system).

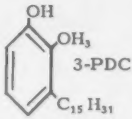
By means of infrared spectrophotometry, involving a synthetic model olefin of known geometric structure, it has been shown that all of the double bonds in the three olefinic components of the poison ivy principle are of the cis form.[18] This fact may have considerable significance in respect to the manner in which these olefins form complexes with proteins in the skin.

It is of interest to point out again that the poison ivy principle is not identical to Japanese lac uroshiol. TABLE 2 summarizes our results on poison ivy and Japanese lac, and compares the structures with those proposed by Majima.

The difference between the two oils is found in the structures of the triolefinic components and in the proportions of the components. The triolefinic component of the lac urushiol is much more reactive chemical-

TABLE 2

THE COMPONENTS OF THE POISON IVY PRINCIPLE AND OF JAPANESE LAC URUSHIOL

Component	*Poison ivy*	*Japanese lac*	
	Symes & Dawson[6]	Sunthankar & Dawson[9]	Majima[8]
Saturated	 3-PDC (Hydrourushiol)	3-PDC (Hydrourushiol)	3-PDC (Hydrourushiol)
Mono-olefin	Δ 8	Δ 8	Δ 8
Diolefin	Δ 8, 11	Δ 8, 11	Δ 8, 14
Triolefin	Δ 8, 11, 14	Δ 8, 11, 13 (conjugated)	Δ8, ?, 14

ly, because of its conjugated system, than is the triolefin of poison ivy. Furthermore, it is the major component of the lac urushiol, whereas the diolefinic component constitutes the major part of the poison ivy principle. As shown in TABLE 3, the two oils are similar only in the proportions of their saturated and mono-olefinic components.

Until recently, none of the pure olefinic components of poison ivy "urushiol" has been available for clinical investigation. The methyl ethers that were separated from the natural extract by chromatography and used for structural characterization of the olefins could not be used clinically because they are inactive. Unfortunately, it is not possible

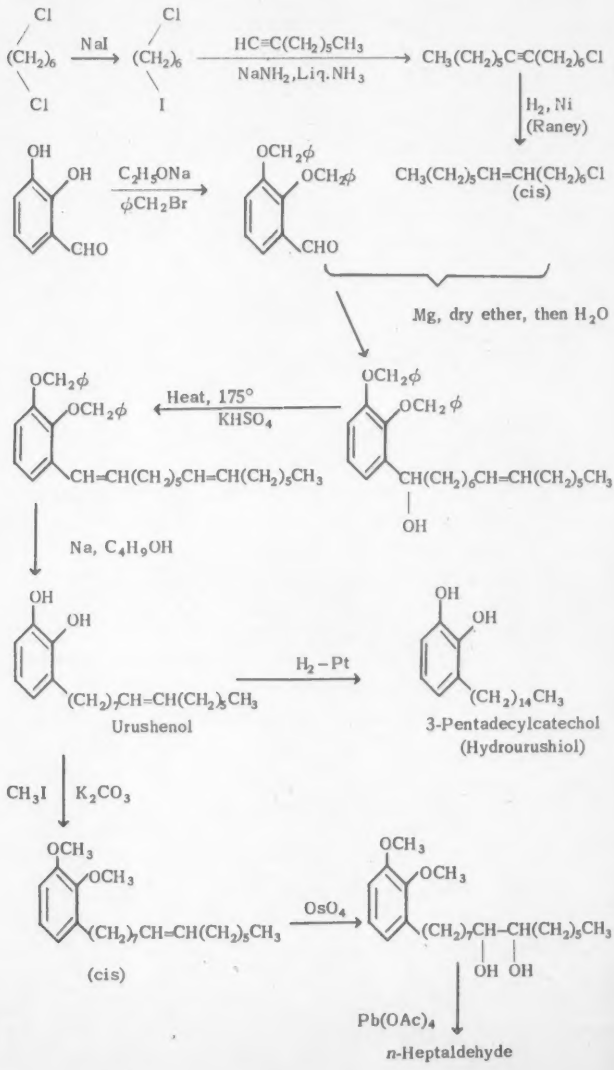
TABLE 3

THE OLIFINIC COMPOSITION OF THE POISON IVY PRINCIPLE AND OF JAPANESE LAC URUSHIOL

Component	Side Chain	Poison Ivy	Japanese Lac
		Approx. %[6]	Approx. %[9]
Saturated	$C_{15}H_{31}$	3	5
Mono-olefin	$C_{15}H_{29}$	20	25
Diolefin	$C_{15}H_{27}$	55	15
Triolefin	$C_{15}H_{25}$	22	55

to demethylate the ethers without destroying the double bonds. For this reason, a method of synthesis for the mono-olefinic component was of considerable interest.

The method developed in our laboratories by Loev,[19] involving the use of benzyl ethers rather than methyl ethers, is shown below.



It can be seen that the critical feature of this method is the reductive cleavage of the benzyl ether groups. The sodium and alcohol reduction does not affect the nonconjugated double bond in the side chain, but does result in reduction of the undesired double bond conjugated with the ring.

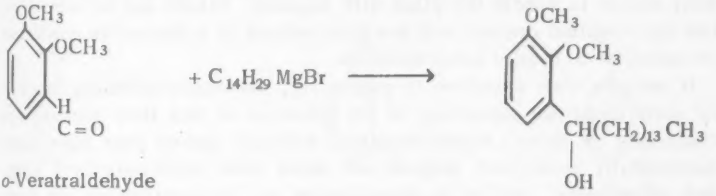
The crystalline saturated component (hydrourushiol or 3-pentadecyl catechol) has been available synthetically for a considerable time. The method which we used in 1943[20,21] to synthesize this compound is shown below.

$$CH_3(CH_2)_{12}CH_2OH + HBr \xrightarrow[H_2SO_4]{} CH_3(CH_2)_{12}CH_2Br + H_2O$$

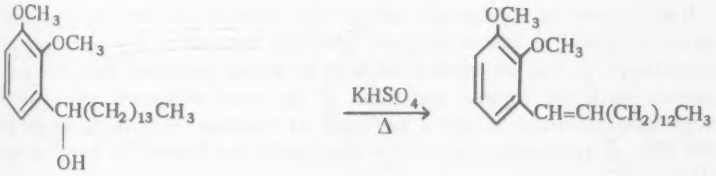
Myristyl alcohol — Myristyl bromide

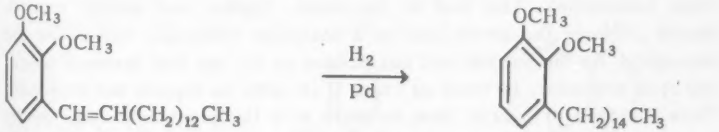
$$CH_3(CH_2)_{12}CH_2Br + Mg \xrightarrow[\text{ether}]{\text{dry}} CH_3(CH_2)_{12}CH_2MgBr$$

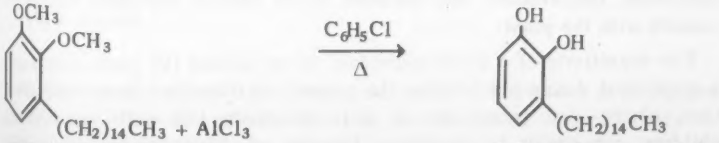
Grignard Reagent



o-Veratraldehyde







3-Pentadecylveratrole — 3-Pentadecylcatechol PDC

This crystalline component which, it will be recalled, is present only in very small amounts in the poison ivy principle, has proved to be a valuable standard agent in clinical investigations (patch testing) of poison ivy sensitivity. Harry Keil, formerly associated with the Skin and Cancer Hospital of New York, N.Y., has used PDC extensively as a standard agent for the diagnosis of poison ivy sensitivity,[22] and has recommended its use in the treatment of acute poison ivy dermatitis.[23] More recently, PDC has been used successfully as a desensitizing agent by Albert Kligman and his associates at the University of Pennsylvania, Philadelphia, Pa.

At the present time, very little is known as to how PDC and the alkenyl catechols of poison ivy bring about the characteristic edema, irritation, and blistering that frequently follow contact with the plant. It is well known that sensitivity to the plant varies widely from one individual to another. Some are relatively "immune" and may brag about their ability to handle the plant with impunity. Others are so sensitive that the slightest contact with the plant results in a dermatitis condition so severe as to require hospitalization.

If animals were sensitive to poison ivy, we should probably know a lot more about the physiology of the condition at this time because we could rely on animal experimentation. Although guinea pigs have been successfully sensitized, they do not retain their sensitivity very long, and experimental results on sensitization and desensitization are very difficult to interpret in human terms.

Many cases of mysterious poison ivy attacks can be explained in terms of animal or insect carriers. Although the poison ivy principle is nonvolatile, it can be carried on dust or smoke particles that come in contact with the injured leaf. One of the most effective ways for a sensitive individual to get a bad case of "poison ivy" is to stand in the path of the smoke from a fire containing the leaves or bark of the plant.

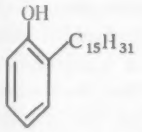
In the spring of the year, the poison ivy leaf is rich in the oily principle (oleoresin). The leaf is succulent, tender, and easily injured. Merely pressing the intact leaf on a sensitive individual will cause the dermatitis. As the summer and fall months go by, the leaf becomes tough, and it is necessary to break or crush it in order to expose the oleoresin. Thus the type of contact that is made with the plant may vary greatly from one season to another. The condition of the skin, particularly as to thickness, temperature, and moisture, is an equally important factor in contact with the plant.

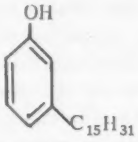
The sensitivity of a given individual to the poison ivy plant may vary a great deal during his lifetime. In general, children are more sensitive than adults, and sensitivity is quite commonly lost with age. Also, children are easier to sensitize. Humans who have never previously

made contact with the plant, such as babies, Eskimos, and many Europeans, do not develop the dermatitis following first contact with the oleoresin. However, subsequent contacts with the plant will result in the dermatitis if the first contact has been sufficiently concentrated to induce sensitization.

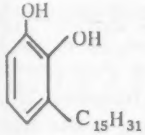
Thus, in considering the relationship between the chemical structure of an alkenyl or alkyl phenol and its "poison-ivylike" activity, two kinds of activity must be differentiated. An alkenyl phenol may be active in the sense that it produces a "poison-ivylike" reaction on people already sensitive to the plant. It may also be active in the sense that it induces sensitization in persons not previously sensitized. A compound that is active in one sense may not necessarily be active (or as active) in the other.

Among the compounds that have been synthesized in our laboratory for the purpose of obtaining information concerning the relationship between structure and activity are the following:

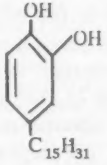


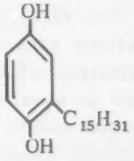


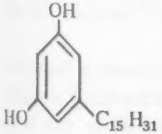
Hydrocardanol



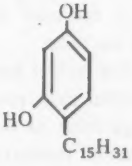
Hydrourushiol

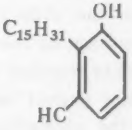






Hydrocardol





Unfortunately, all of these compounds have not yet been investigated clinically on human patients. However, as the result of patch tests involving some of the above compounds and a number of others that we

synthesized earlier, certain relationships between structure and activity have been elaborated.[20]

(1) The activity of compounds of this kind in eliciting a "poison-ivylike" reaction on people already sensitive to the plant is dependent on the presence of free phenolic groups. Methylation greatly reduces this activity.

(2) The 1-2 and 1-3 dihydric phenols are more active in producing the patch test reaction than the 1-4 and the monohydric phenols.

(3) The position of the side chain and its length and degree of unsaturation are important.

In regard to the last point, it is of interest to note that 4-pentadecylcatechol is much less active in eliciting a "poison-ivylike" reaction among people already sensitive to the plant than is 3-pentadecylcatechol (PDC). Hydrocardol, the 3-pentadecyl resorcinol, appears to have the same order of activity as hydrourushiol. However, when the side chain is located in the position adjacent to one of the phenolic OH groups of resorcinol, as in 4-pentadecyl resorcinol, the compound is inactive. Alkyl catechols carrying side chains considerably shorter than 15 carbons are less effective in producing positive skin reactions. It seems likely, therefore, that the fat-solubility of the phenol is a factor in its activity. Although the evidence is limited, it appears that the introduction of olefinic bonds in the side chain greatly increases the incidence and intensity of the allergenic reaction. In this connection it is pertinent to point out that the olefins are oily liquids and probably more fat-miscible than the crystalline phenols bearing saturated side chains.

The above points in regard to the relationship between structure and activity suggest that the alkyl and alkenyl catechols of the poison ivy principle, when brought into contact with the skin, form a complex with one or more specific proteins of the skin. It is the formation of this protein-phenol complex that initiates the events leading to the typical clinical symptoms of poison ivy dermatitis. The formation of such a complex apparently occurs to a maximum extent when the phenolic hydroxyl groups are in the proper positional relationship to each other and when the side chain is of optimum length and is located in the proper position on the phenolic nucleus.

If the skin reaction involves the initial formation of a complex between the alkenyl phenol and a specific skin protein, then structural details such as the geometrical configuration of the olefinic bonds in the side chain may be of great importance. Investigations designed to give information on this point are now in progress in our laboratories. We are also developing a method to obtain each of the pure olefinic components in the active (free phenol) form directly from the plant extract. It will be recalled that, at the present time, only the inactive methyl ethers can be separated in pure form from the plant extract; only the saturated and the

mono-olefinic components have been available by synthesis for clinical investigation. It is hoped that when the diolefinic and triolefinic catechols are available for clinical study, more information concerning the mode of action of the poison ivy principle may be obtained. In the meantime, the clinical studies involving the use of the saturated component PDC as a desensitizing agent are continuing in Albert Kligman's laboratory.

These studies, which have thus far involved more than 2,000 patients, have revealed that individuals sensitive to the poison ivy plant can be made "immune" or refractory to the plant by a course of intramuscular injections of PDC extending over a period of several weeks. The lower level of sensitivity can be maintained by two to four injections per year.

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SECTION OF BIOLOGY

THE SIGNIFICANCE OF ALTERATIONS IN SERUM GLUTAMIC OXALOACETIC TRANSAMINASE IN EXPERIMENTAL AND CLINICAL STATES*

By Felix Wróblewski

Memorial Center for Cancer and Allied Diseases, New York, N. Y.

Glutamic oxaloacetic transaminase (GO-T) is an enzyme that catalyzes the reversible transfer of the α-amino nitrogen of aspartic acid to α-keto glutaric acid with the resulting synthesis of glutamic and oxaloacetic acids (FIGURE 1). This enzyme is widely distributed in animal and human tissues, and has been found in all animal and human sera tested. Serum glutamic oxaloacetic transaminase (SGO-T) may be measured chromatographically,[1] spectrophotometrically,[1,2,3] and colorimetrically[4] (FIGURE 2).

Following the death of tissue, GO-T is liberated from its cellular confines. Because of its high concentration in cardiac tissue, GO-T is liberated in sizable activity following heart-tissue necrosis. Experimental myocardial infarction has been produced in dogs, using various techniques. Myocardial infarction in the dog is followed by an increase in SGO-T activity.[5,6] The increase occurs within six hours following infarction, and both the degree and the duration of enzyme abnormality appear to be proportional to the size of the infarct. Myocardial ischemia of 45 minutes duration fails to influence SGO-T significantly. Since the enzyme activity of infarcted muscle is 2 to 10 per cent of that of normal cardiac tissue, the mechanism of elevation of SGO-T is probably through release of the enzyme into the blood stream following an increase in the permeability of the injured heart muscle cell.

In patients with acute transmural myocardial infarction, SGO-T activity rises 2 to 20 times normal during the first three days[7] (FIGURE 3). There appears to be a rough correlation between height of SGO-T activity and the size of the myocardial infarct. SGO-T is unaffected by angina pectoris, coronary insufficiency, heart failure, digitalis, and anticoagulants in the absence of active heart-cell damage. In differential diagnosis of myocardial infarction, SGO-T contributes in the differentiation between pericarditis, myocarditis, pulmonary infarction, and myocardial infarction.

Experimental injury to hepatic tissue is associated with a rise in SGO-T, and the elevation in the serum enzyme is proportional to the degree of injury. The instillation of carbon tetrachloride in rats results in a rise in SGO-T; the peak rise is directly related to the extent of

*This paper, illustrated with lantern slides, was presented at a meeting of the Section on February 13, 1956.

liver-cell necrosis which, in turn, is proportional to the amount of toxin administered[8] (FIGURE 4). Human toxic hepatitis, whether due to carbon tetrachloride or to hepatotoxic drugs, is associated with a rise in SGO-T, and a gradual fall of SGO-T activity to normal results when the toxic agent is withdrawn.[9] Experimental viral hepatitis in mice has been found to be associated with an increase in SGO-T.[10] A relationship exists between the rise in SGO-T activity and (1) the size and virulence of the virus inoculum (FIGURE 5); (2) the blood virus titer (FIGURE 6); and (3) the degree of liver-cell injury. Although mouse hepatitis differs from human hepatitis in the incubation period, histologic changes, and natural course, both human and experimental virus hepatitis result in comparable changes in SGO-T.

SGO-T activity is impressively elevated in patients following acute liver-cell injury due to carbon tetrachloride poisoning (FIGURE 7), in infectious hepatitis (FIGURE 8), and in homologous serum hepatitis (FIGURE 9).[11] The serum enzyme in patients with acute liver-cell injury is usually greater than seen in extrahepatic biliary obstructive jaundice. Cirrhosis of the liver may be associated with normal SGO-T activity, with mildly elevated levels, and with high activity, apparently depending on the state of remission of the disease. An increase in SGO-T activity appears to be a relatively sensitive index of liver metastases. The serum enzyme appears to be a parameter of liver-cell injury and does not necessarily correlate with the usual tests of liver dysfunction.

Infectious, neoplastic, congenital, traumatic, allergic, and reactive disease states do not significantly alter SGO-T unless there is concomitant involvement and injury to cardiac muscle, skeletal muscle, and/or hepatic tissue. The quantitative and serial alterations of SGO-T are sufficiently characteristic in various hepatic and cardiac diseases to assist in differential diagnosis when the serum enzyme elevations and serial changes are correlated with the clinical setting.

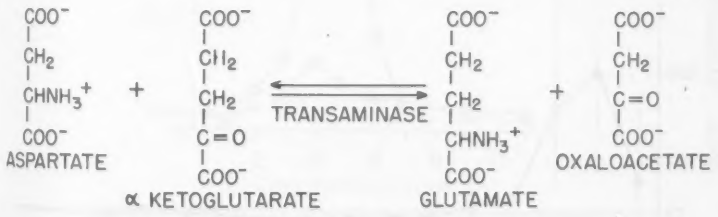


FIGURE 1.

SGO - TRANSAMINASE ASSAY METHODS

Chromatographic

$$\text{asparate} + \alpha\text{-keto glutarate} \overset{\text{SGO-T}}{\rightleftharpoons} \text{glutamate} + \text{oxaloacetate}$$

formation of glutamate after 3 hrs.

Spectrophotometric

$$\left\{\begin{array}{l} \text{asparate} + \alpha\text{-keto glutarate} \overset{\text{SGO-T}}{\rightleftharpoons} \text{glutamate} + \text{oxaloacetate} \\ \text{oxaloacetate} + \text{DPNH} + \text{H}^+ \overset{\text{malic dehydrogenase}}{\rightleftharpoons} \text{malate} + \text{DPN}^+ \end{array}\right.$$

rate of disappearance of $DPNH_2$

Colorimetric

$$\left\{\begin{array}{l} \text{asparate} + \alpha\text{-keto glutarate} \overset{\text{SGO-T}}{\rightleftharpoons} \text{glutamate} + \text{oxaloacetate} \\ (\text{oxaloacetate} \longrightarrow \text{pyruvate} \longrightarrow) \end{array}\right.$$

formation of pyruvate after 20 min.

FIGURE 2.

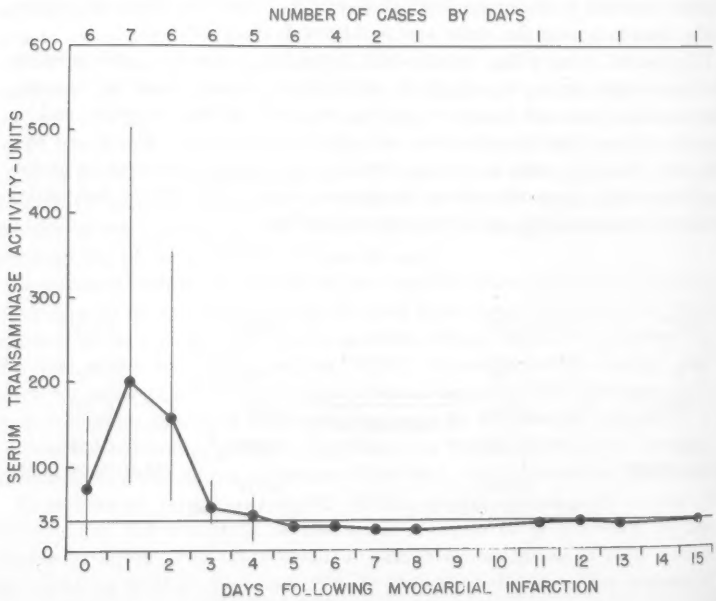


FIGURE 3.

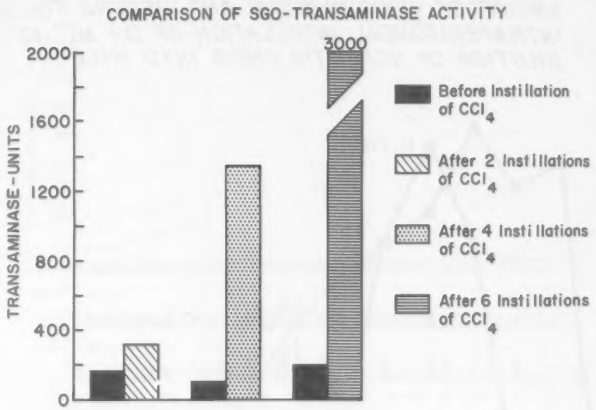
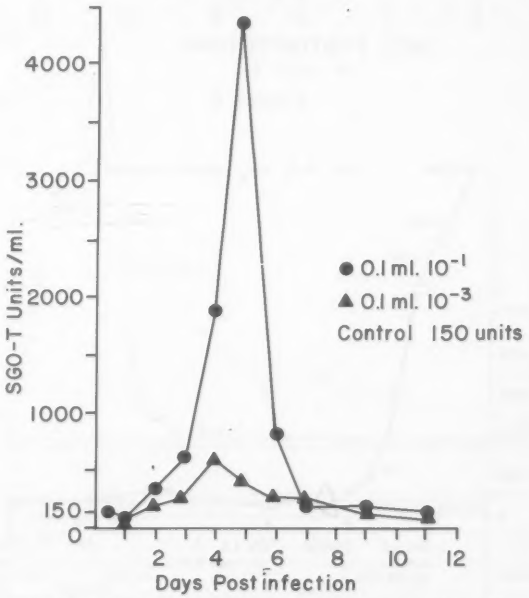


FIGURE 4.



SGO-T Activity in mice following intraperitoneal inoculation of 0.1ml. 10^{-1} and 0.1ml. 10^{-3} dilution of hepatitis virus.

FIGURE 5.

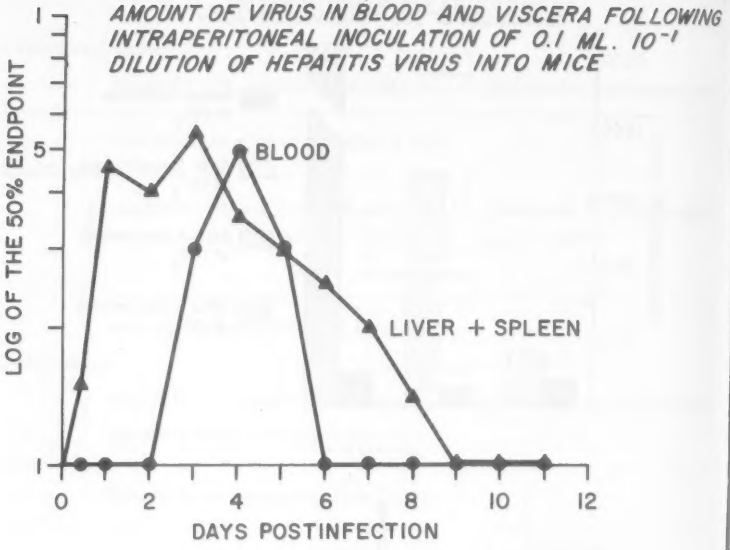

AMOUNT OF VIRUS IN BLOOD AND VISCERA FOLLOWING INTRAPERITONEAL INOCULATION OF 0.1 ML. 10^{-1} DILUTION OF HEPATITIS VIRUS INTO MICE
LOG OF THE 50% ENDPOINT
BLOOD
LIVER + SPLEEN
DAYS POSTINFECTION

FIGURE 6.

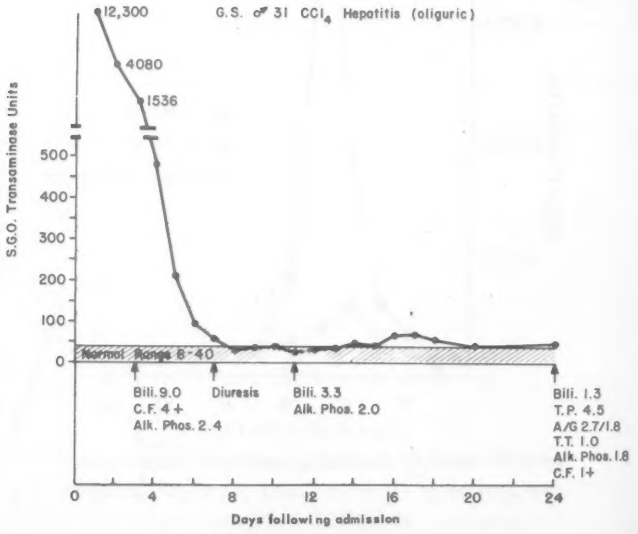


FIGURE 7.

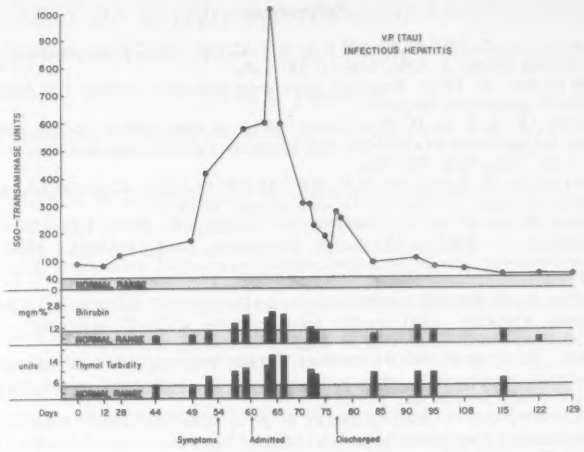


FIGURE 8.

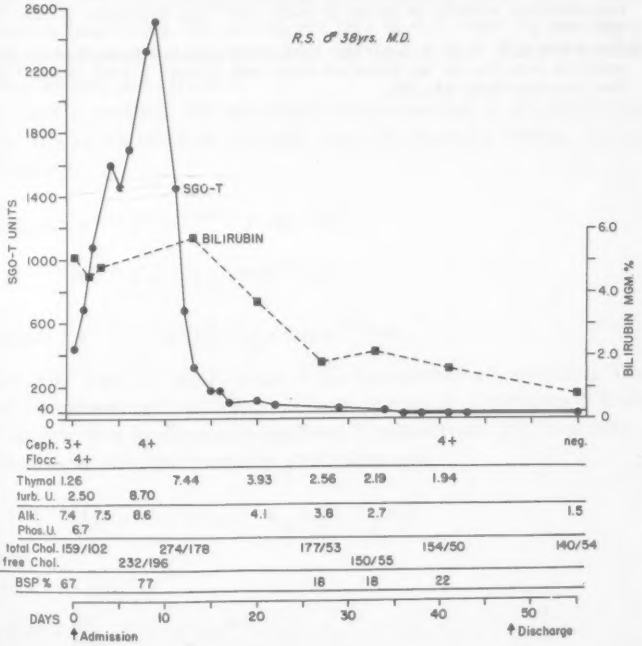


FIGURE 9.

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SECTION OF MATHEMATICS AND ENGINEERING

WAVE FRONTS DERIVED FROM FOURIER TRANSFORMS*

By W. S. Jardetzky

Columbia University and Manhattan College, New York, N. Y.

The outlines of a discussion of wave propagation in elastic layered media have been given by Lamb.[4] Sommerfeld[8] found the first solution in a similar problem for electromagnetic waves. In order to avoid the use of divergent Fourier integrals, Sobolev and Smirnoff[7] developed a new method based on the theory of characteristics. To determine the wave fronts corresponding to different kinds of waves was one of the main purposes in their investigation, as it was in the theory of Cagniard.[2] In the latter, the solutions were obtained in the form of Laplace transforms, which were considered also by Bromwich.[1] In two-dimensional problems, Lapwood[5] and Newlands[6] derived different kinds of waves applying the method of steepest descent to terms of a series representing the solution. The general solutions in investigations that follow Lamb's or Sommerfeld's methods are usually obtained from steady state solutions by Fourier transforms. We can expect that in this case, by modifying the approach, we shall be able to derive the wave fronts from the transforms as soon as they are obtained.

In Lamb's problem, the potentials corresponding to displacements at a point $M(r,z)$ are taken in the form (see, for example, Ewing, Jardetzky, and Press[3]).

$$\phi(r,z,t) = e^{i\omega t}\int_0^\infty e^{-\nu|z-h|} J_0(kr)\frac{kdk}{\nu} + e^{i\omega t}\int_0^\infty Q(k) J_0(kr) e^{-\nu z} dk \tag{1}$$

$$U(r,z,t) = e^{i\omega t}\int_0^\infty S(k)\frac{d}{dr}[J_0(kr)]\, e^{-\nu' z} dk \tag{2}$$

The first term in EQUATION 1 is Sommerfeld's expression for the direct compressional wave from a point source at a distance h from the free surface of a semi-infinite medium. The functions $Q(k)$ and $S(k)$ must be determined from the boundary conditions and

$$\nu = \sqrt{k^2 - k_\alpha^2},\quad \nu' = \sqrt{k^2 - k_\beta^2},\quad k_\alpha = \frac{\omega}{\alpha},\quad k_\beta = \frac{\omega}{\beta} \tag{3}$$

It is

$$Q(k) = -\frac{kf(k)}{\nu F(k)} e^{-\nu h} \tag{4}$$

$$S(k) = \frac{4k}{F(k)}(2k^2 - k_\beta^2) e^{-\nu h} \tag{5}$$

*This paper was presented at a meeting of the Section on February 17, 1956.

$$F(k) = (2k^2 - k_\beta^2)^2 - 4k^2 \nu \nu^1 \tag{6}$$

$$f(k) = (2k^2 - k_\beta^2) + 4k^2 \nu \nu^1 \tag{7}$$

Substituting the well known expression for the Bessel function of zero order

$$J_o(\zeta) = \frac{1}{\pi} \int_o^\pi e^{-i\zeta \cos\sigma} d\sigma, \tag{8}$$

$$k = \omega u, \; u = \frac{k}{\omega} = \frac{1}{c}, \; \nu = \omega a, \; \nu^1 = \omega b \tag{9}$$

EXPRESSION 2, for example, takes the form

$$U(r,z,t) = e^{i\omega t} \int_o^\infty du \int_o^\pi S_u e^{-i\omega (ur \cos\sigma - iha - izb)} \cos\sigma \, d\sigma \tag{10}$$

In order to make the integrands uniform functions, the conditions $Re\nu > 0$, $Re\nu^1 > 0$ must be attended to, *i.e.*, only the admissible sheet of the Riemann surface corresponding to the radicals ν and ν^1 must be considered. A new form of EXPRESSION 10:

$$U = e^{i\omega t} \int_o^\infty e^{-i\omega v} T(v,r,z) \, dv \tag{11}$$

can be obtained by substituting first

$$v = ur \cos\sigma - iha - izb \tag{12}$$

Similar parameters u and v used by Cagniard in Laplace transforms play an important part in his discussion. By EQUATION 9 u is the inverse phase velocity, and v has the dimension of time, if real. We have

$$v = v_o = \frac{h}{\alpha} + \frac{z}{\beta} \qquad for\ u = 0 \tag{13}$$

$$v = v_1 = \frac{r}{\alpha} \cos\sigma + z \sqrt{\frac{1}{\beta^2} - \frac{1}{\alpha^2}} \tag{14}$$

$$v = v_2 = \frac{r}{\beta} \cos\sigma - ih \sqrt{\frac{1}{\beta^2} - \frac{1}{\alpha^2}} \tag{15}$$

To obtain EXPRESSION 11 we note that the integration with respect to a real u in EXPRESSION 10 has to be replaced first by the integration along a contour C_σ in the complex v plane, *i.e.*,

$$U = e^{i\omega t} \int_o^\pi d\sigma \int_{C_\sigma} S_v \, e^{-i\omega v} \frac{\partial u}{\partial v} dv \tag{16}$$

It is obvious now that singularities of the integrand can occur in the factors S_v and $\partial u / \partial v$. The real root $u_R = 1/c_R$ of the Rayleigh equation $F(u) = 0$ will determine a pole P on c_σ ($-1/c_R$ is the root in the left-hand half plane) because of EQUATIONS 5 and 6 and

$$v_R = u_R \, r \cos\sigma - ih \sqrt{u_R^2 - \frac{1}{\alpha^2}} - iz \sqrt{u_R^2 - \frac{1}{\beta^2}} \tag{17}$$

The singularities due to the factor $\partial u/\partial v$ are the roots of $\partial v/\partial u = 0$, and by EQUATION 12 we obtain

$$r \cos \alpha - \frac{iu}{\sqrt{1/\alpha^2 - u^2}} - \frac{zu}{\sqrt{1/\beta^2 - u^2}} = 0 \tag{18}$$

Putting the second and third terms equal to $h \tan \gamma_1 = r_1 \cos \sigma$ and $z \tan \gamma_2 = r_2 \cos \sigma$ respectively we can use the interpretation found by Cagniard for Laplace transforms. EQUATION 18 can be represented by FIGURE 1. For $\sigma = 0$ this figure is replaced by FIGURE 2, which yields an explanation of that part of the problem which refers to the propagation of a compressional wave from the source S to a point K of the free surface and a reflected shear wave reaching the observer M. SK and KM are obviously the rays, and the elements of wave fronts *(df)* are perpendicular to them at every point. The time of arrival at M follows from EQUATION 12, the transformation of EQUATION 18 mentioned above, and FIGURE 2. It is

$$\hat{v} = \frac{r \sin \hat{\gamma}_1}{\alpha} + \frac{h \cos \hat{\gamma}_1}{\alpha} + \frac{z \cos \hat{\gamma}_2}{\beta} = \frac{D_1}{\alpha} + \frac{D_2}{\beta} \tag{19}$$

The assumption that $\sigma = 0$ corresponds also to the front of Rayleigh waves gives, by EQUATION 17, a complex $v_R = v^I + iv^{II}$. Then the exponential factor in EQUATION 16 becomes

$$\exp\,[i\omega(t - v^I)]\ \exp\left(-wh\sqrt{u_R^2 - \frac{1}{\alpha^2}}\right) \exp\left(-\omega z \sqrt{u_R^2 - \frac{1}{\beta^2}}\right) \tag{20}$$

The time of arrival at a distance r is given by $v^I = u_R\, r = r/c_R$.

If a similar transformation is applied to the potential ϕ we must note first that the direct wave is already separated. Then in the second integral in *(1)* the new parameter is given by the equation

$$v_\phi = ur \cos \sigma - iha - iza \tag{21}$$

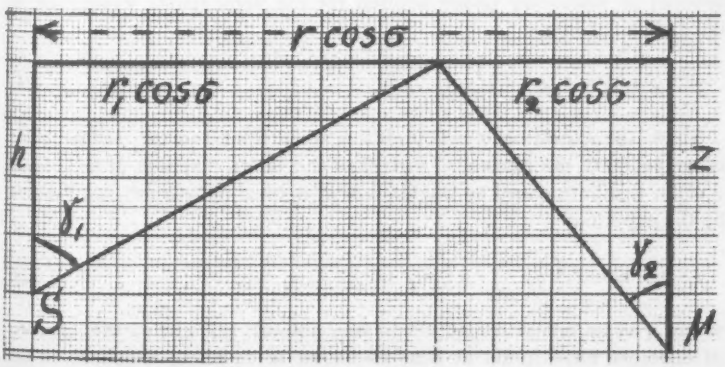

FIGURE 1: Approximately 2:1.

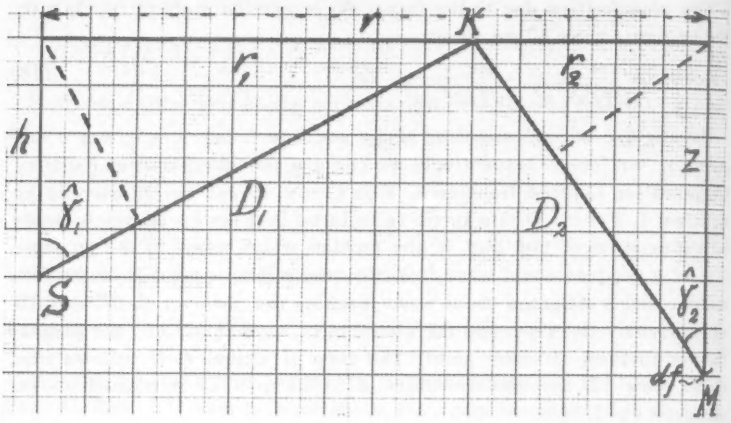

FIGURE 2.

This relation can be illustrated by figures similar to FIGURES 1 and 2. Besides the Rayleigh waves there will be an algebraic singularity of the integrand involved which is determined by the root of $\partial v_\phi / \partial u = O$. The time of arrival corresponding to this singularity is

$$\hat{v}_\phi = \frac{D_1 + D_2}{a} \tag{22}$$

i.e., arrival of the reflected compressional wave. For the direct wave the method yields

$$v_d = u r \cos \sigma - i (z-h) a, \quad \hat{v}_d = \frac{R}{a} \tag{23}$$

for $\sigma = O$. It can be easily seen that EQUATION 18 or $\partial v / \partial u = 0$ in general is equivalent to conditions for a saddle point in methods of steepest descent or stationary phase applied for the approximate evaluation of integrals of the type

$$\int_{-\infty}^{\infty} \chi(\zeta) \exp(i\omega t - i\zeta x + \ldots) d\zeta \tag{24}$$

Thus, the condition $\sigma = O$ yields a wave front and the saddle point corresponds to the moment of arrival of the latter. The use of a variable v of the type introduced by Cagniard or u_σ defined by Smirnoff and Sobolev by the equation

$$t - u_\sigma r \cos \sigma \pm z \sqrt{\frac{1}{a^2} - u_\sigma^2} = \chi(u_\sigma) \tag{25}$$

where χ is an analytic function is very helpful. It clarifies the question of different wave fronts at first as shown in detail by Cagniard in the case of two elastic half spaces in contact. The discussions of problems

concerning the line source are less convincing because the results are based on approximate evaluation of integrals. Using series expansions for the solution of his problem immediately after it has been written, Lamb separated the Rayleigh waves only as a main physical reality and omitted the discussion of wave fronts.

We restrict ourselves here by noting that the evaluation of "transmission coefficients" *(e.g. T (v, r, z)* in EQUATION 11) in the sense used by Cagniard should be the next step in the discussion. This evaluation, however, requires extensive study.

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SECTION OF PSYCHOLOGY

THE PLACE OF PSYCHOLOGY IN UNESCO'S SOCIAL SCIENCE PROGRAM*

By Otto Klineberg

Department of Psychology, Columbia University, New York, N. Y.

On the occasion of the Second Session of the UNESCO General Conference, held in Mexico City, Mexico, toward the end of 1947, a decision was made that gave psychology and other social sciences a significant place in UNESCO's program. A resolution was adopted setting up a project on "Tensions Affecting International Understanding" (the Tensions Project), which was to mobilize the knowledge and the techniques of the social sciences in an attempt to discover the principal factors responsible for tensions among nations, as well as the techniques which might be applied to the reduction of such tensions.

A number of concrete decisions regarding areas of study were made at Mexico City. These decisions were slightly modified at the next session of the General Conference at Beirut, Lebanon, in 1948. The text of these decisions reads as follows:

The Director-General is instructed to promote enquiries into: (1) the distinctive character of the various national cultures, ideals, and legal systems; (2) the ideas which the people of one nation hold concerning their own and other nations; (3) modern methods developed in education, political science, philosophy, and psychology for changing mental attitudes, and into the social and political circumstances that favor the employment of particular techniques; (4) the influences that make for international understanding or for aggressive nationalism; (5) population problems affecting international understanding, including the cultural assimilation of immigrants; and (6) the influence of modern technology upon the attitudes and mutual relationships of peoples.

During the years that followed, a number of interesting studies were undertaken and, although there may have been some disillusionment with the project on the part of those who had expected it to resolve international tensions, the more modest and realistic participants and observers felt that genuine progress was being made. There were direct results in the form of new investigations, the publication of the results of these investigations and of social science data previously gathered but not easily accessible, requests from member states for studies of tensions within their own borders, *etc.* There were equally important indirect results in the facilitation of international cooperative research in the social sciences, the dissemination of information regarding research

*This paper was presented at a meeting of the Section on February 20, 1956.

methods, the encouragement of new research, and the stimulation of scholars and institutions outside of UNESCO to direct some of their research energies into international channels. It is perhaps indicative of at least a measure of success that when the writer returned to UNESCO for a second tour of duty from 1953 to 1955 (the first was in 1948-1949), he found that the Tensions Project had expanded into a Division of Applied Social Sciences, with a somewhat increased budget, a larger staff, and a more diversified program.

During this two-year period, the Division's activities proceeded along four main lines, the first three of which emerged more or less directly from the original project. Before describing these, the writer wishes to draw attention to certain major characteristics of the program as a whole; first, the tendency to insist on practical implications of all activities undertaken directly by UNESCO; second, the tendency to assign research activities to international social science organizations having consultative status with, and usually receiving subventions from UNESCO; third, the tendency to regard "aid to member states" as one of UNESCO's primary responsibilities.

As for the program itself, the first main unit in the Division of Applied Social Sciences related directly to the problem of "international understanding and misunderstanding." This is the former "Tensions Project" in its most direct form. Earlier activities in this area of special interest to psychologists had included the publication of *Tensions that Cause Wars*, edited by Hadley Cantril, based on a symposium on the subject bearing this title, and the writer's *Tensions Affecting International Understanding*, as well as the autumn, 1951, number of the *International Social Science Bulletin* devoted to "National Stereotypes." In 1953 two significant studies appeared. The first, *How Nations See Each Other*, by W. Buchanan and H. Cantril, presents the results of a public opinion study conducted in 8 countries, in each of which about 1,000 respondents were questioned. The second, *The Teacher Was Black*, by H.E.O. James and C. Tenen, reports the effects on school children in London, England, of a period of contact with two African Negro schoolteachers. Between 1953 and 1955 there appeared four "community studies," two each from Australia and France, representing a contribution both to the understanding of national characteristics, and to the development of a combined psychological-sociological-ethnological methodology in this field.

Now completed and in the process of publication, under the auspices of the International Sociological Association, is a new critical survey of the recent literature relevant to tensions, tentatively entitled *Conflicts and Wars*. The specifically psychological chapter has been contributed by T. H. Pear, formerly of the Victoria University of Manchester, Manchester, England. The International Union of Scientific Psychology is preparing a critical account of the present status of research on national

characteristics; this is being written by H. C. J. Duijker of Amsterdam, the Netherlands. The IUSP is also projecting an international study of the origin and development of national stereotypes in children.

Two other general surveys almost completed are relevant in this connection. The first is being directed by Stuart Dodd of the University of Washington, Seattle, Wash. for the World Association for Public Opinion Research (WAPOR) and deals with the international comparability of public opinion studies. It is hoped that this may pave the way for trend studies of international attitudes in various countries. The second survey is being made by the Institute for Social Research at Oslo, Norway, under the direction of Stein Rokkan. It will complement the first, paying special attention to survey methods and content analysis as international research tools. UNESCO is also aiding WAPOR in the collection of the results of public opinion studies in various countries during the past 8 to 10 years.

In this whole area, one of the most striking developments has been in connection with internal tensions, *i.e.* within a single nation. Psychologists are undoubtedly familiar with the book by Gardner Murphy, *In the Minds of Men* (1953), which resulted from a request by the government of India for aid in the study of relationships between Hindus and Moslems, as well as other religious and ethnic groups in India. This series of investigations was conducted with the cooperation of a number of Indian social scientists, and the Indian government supplemented UNESCO's subvention so that the research might continue. Murphy is just back from a second trip to India, and he reports that interest and activity in this field are continuing. There have been other studies of internal tensions, one in Japan under the direction of Jean Stoetzel of Paris, described in his *Without the Chrysanthemum and the Sword* (1955), and one in Germany, reported by K. Pipping of Finland in *Gespräche mit der deutschen Jugend* (1954). Both of these deal with tensions between the generations, rather than between ethnic groups. Arvid Brodersen of Norway and a group of Israeli colleagues have been studying the tensions that have arisen as the result of the migration to Israel of persons with varying cultural backgrounds. The results of this series of studies will be published in the next issue of *The International Social Science Bulletin.* A study is also projected of the relations between Walloon (French-speaking) and Flemish students in Belgium.

The second major direction in which the Division of Applied Social Sciences has moved relates to the question of human rights and, more particularly, to the problem of race. Largely as the result of a specific request from the Economic and Social Council of the United Nations, UNESCO has undertaken to disseminate scientific facts concerning race, along the lines called for by Gunnar Myrdal when he spoke of a necessary "educational offensive" to reduce the gap between popular and scientific opinion in this important field. This has been done by calling together

groups of social and biological scientists who have issued statements representing their consensus regarding race; by publishing a series of scientific pamphlets that are among UNESCO's "best sellers," some of which have appeared in five or more languages; by describing the progress made in race relations in various countries, *etc.* Not only scientists, but also religious leaders have joined in this educational task. This whole program has attracted favorable attention in most member states, with the notable exception of the Union of South Africa, which has informed UNESCO that it no longer wishes to be considered a part of the organization.

Related to the above is a series of demographic studies, including several on the adaptation and integration of immigrants. One of these, on the cultural contributions by immigrants to their new homeland, was jointly sponsored by the International Sociological Association and the International Economic Association, and has recently appeared (1955) under the title, *The Positive Contributions by Immigrants*, by Oscar Handlin and others.

Nor has the largest minority of all been neglected! There have been several studies of the status of women; two have been published. One is on *The Status of Women in South Asia* (1954) by Appadorai and others; the second deals with *The Political Role of Women* in various countries, and has been edited by the French political scientist, Duverger (1955).

The third major area of concern has to do with what is called the Social Implications of Technological Change. In the earlier stages of this activity, interest was directed mainly to modern industrial societies but, with the launching of "Point Four" and, later, the United Nations Technical Assistance program, the focus shifted to the so-called underdeveloped areas. UNESCO was probably one of the first organizations to recognize the importance of paying due attention to human factors in technological change, to cultural attitudes and values, and to the total social setting into which change was being introduced. The World Federation for Mental Health was asked to prepare a volume on this topic, and it appeared in 1953 under the title, *Cultural Patterns and Technical Change*, edited by Margaret Mead. It has been one of the most successful of UNESCO's publications. A similar theme was developed in *Social Aspects of Technical Assistance in Operation*, edited by Morris Opler (1954), which summarizes the results of an important meeting held on this subject under joint United Nations-UNESCO auspices.

Two major developments in this connection should be noted. The first is the establishment in Paris of an International Research Office on the Social Implications of Technological Change, under the auspices of the International Social Science Council. This office serves as a clearinghouse of information on this topic, and also carries out specific investigations. One of these investigations, now in progress under the

direction of the French anthropologist G. Balandier, who is also the head of the Research Office, is concerned with objective indices of social disorganization, *e.g.* crime, delinquency, and mental abnormality in areas undergoing rapid industrialization or urbanization, and with the comparison of situations in which such indices are high or low, respectively. The second major development is the creation by UNESCO of a regional center to deal with similar problems in southeast Asia, and to carry out specific investigations as requested by the governments of member states in that area. The seat of the center is Calcutta, India, and the organization of activities and recruitment of personnel is now proceeding.

Although the role of the psychologist may appear secondary in the case of projects related to human rights and technological change, there can be no doubt regarding its primacy in the fourth major subdivision, namely that which is concerned with evaluation. The problem here is to develop and describe techniques that can aid in the determination of the success or failure of "action programs," and to improve such programs as a consequence. It has not been easy to "sell" the idea of evaluation but, on the whole, the response to efforts along these lines has been favorable. An example of activities in this direction is the issue of the *International Social Science Bulletin* (vol. VII, no. 3, 1955), devoted to Evaluation Techniques. The articles in this volume were collected by the International Social Science Council for UNESCO; they include contributions from many of our psychological colleagues, *e.g.* Marie Jahoda, Claire Selltiz, and E. Barnitz of New York University, New York, N.Y., Ernest Beaglehole of New Zealand, M. Brewster Smith of the Social Science Research Council, New York, N.Y., and K.M. Miller of the University of Tasmania, Hobart, Tasmania. There are also articles by Louis Moss of the British Ministry of Information, New York, N.Y., and by Charles Wright of the Bureau for Applied Social Research at Columbia University, New York, N.Y. In addition, George Ferguson of McGill University, Montreal, Canada, prepared a schedule to be used for the evaluation of fellowships in the UNESCO Exchange of Persons program, and Wallace Lambert, of the same university, has indicated the methods which might be used for the evaluation of seminars. A Swedish statistician, Sten Wahlund, and a British psychologist, G.E.R. Burroughs, have experimented with evaluation techniques in connection with Fundamental Education projects in Ceylon and Thailand.

This has been an incomplete review, written for psychologists primarily, of a small portion of UNESCO's program. It may perhaps have given some notion of an interesting, perhaps even an exciting, series of undertakings. Although no serious international tensions may be resolved as a consequence, the activities here described do seem to the writer to have significant theoretical and practical implications. How they will develop in the future is still uncertain. Whether, in the long run, they

are to succeed will depend largely on the research findings and methods of psychologists everywhere. The task cannot be accomplished in UNESCO House alone.

DIVISION OF MYCOLOGY

ACQUIRED RESISTANCE IN EXPERIMENTAL HISTOPLASMOSIS*

By S. B. Salvin

United States Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratory, Hamilton, Mont.

Resistance against histoplasmosis can be acquired in experimental animals. This is the first of the deep mycotic infections where such resistance has been demonstrated experimentally.

I should like to draw upon our experiences of the past few years[1-10] and present some of the evidence we have that (1) acquired resistance to infection with *Histoplasma capsulatum* can be induced in the Swiss albino mouse and, to a more limited extent, in the guinea pig; (2) that this resistance can result either from the injection of dead cells or their fractions, or from actual sublethal infection; and (3) that hypersensitivity customarily accompanies the development of resistance, although the two may not be necessarily related. In addition, preliminary data have been obtained on the relative importance of the humoral and cellular systems in this immunity.

Sublethal Infection of Normal Mice and Guinea Pigs

In order that acquired resistance may be better understood, let us first briefly summarize some of the characteristics of histoplasmosis in non-immunized animals. These experiments were conducted in Swiss albino male mice, 21 to 35 days of age, or in guinea pigs weighing about 450 gr. Also, the experiments were conducted with the yeast phase of only one isolate of *H. capsulatum*, grown at 37° C. in a chemically defined liquid medium under constant rotation. In determination of antibodies, precipitation and complement-fixation tests were used. The antigen in the precipitation test was a filtrate from the growth of the yeast phase in broth. In the complement-fixation test, a saline suspension of the cells of the yeast phase, killed by heating at 56°C. for one hour, was used as antigen.

(1) Mice or guinea pigs inoculated intraperitoneally with sublethal doses of 10 to 1,000,000 cells had the greatest numbers of fungus cells in the tissues (spleen, liver, brain, kidney, and lungs) at approximately the second week after inoculation. Subsequently, there was a gradual decline in the number of culturally positive tissues per animal. The spleen proved to be the most readily infected tissue.

(2) Mice inoculated intraperitoneally with 10^6 cells of the yeast phase had a marked development of the fungus in the liver and spleen, so that

*This paper, illustrated with lantern slides, was presented at a meeting of the Division on February 24, 1956.

by 12 hours after injection there were 10^3 to 10^5 fungus cells per gram of splenic tissue. The numbers of fungus cells seemed to remain at the same high level during the first two weeks after injection. Thereafter there was a gradual decrease in the number of viable cells, with occasional mice still having 10^2 or more cells of *H. capsulatum* per gram of spleen 4 to 5 months after injection.

(3) Relatively few infected mice developed detectable antibodies (i.e., precipitins or complement-fixing antibodies). There was no apparent relationship between the presence or absence of fungus in the tissues and the presence or absence of the detectable antibodies.

(4) Few of the guinea pigs developed detectable precipitins, and then only in low titers. However, complement-fixing antibodies appeared in many of the animals, frequently in high titers. The greater the number of fungus cells in the inoculum, the sooner complement-fixing antibodies appeared and the higher the antibody titer tended to become. Although the fungus was most readily isolated from the guinea pig tissues (spleen, liver, kidney, and blood) during the first four weeks after inoculation, the percentage of guinea pigs with complement-fixing antibodies remained relatively high until the termination of the experiment 16 weeks after injection. The complement-fixing titers reached their peak during the sixth to eighth weeks after inoculation under the experimental conditions used.

The course of the disease varies according to the route used for the introduction of the yeast cells, since there is a tendency for an accumulation of fungus cells at the site of inoculation. Thus an intracerebral injection tends to produce a marked infection of the brain, whereas an intranasal injection results in an infection of the lung. However, regardless of the route of inoculation, the fungus tends to spread to the spleen and liver.

Increased Resistance of Mice After Injection of Dead Cells of the Yeast Phase

Six to 14 days after injection with dead cells of the yeast phase, mice resisted a dose lethal for normal animals, that consisted of about 2×10^7 cells given intracerebrally or 4×10^9 cells injected intraperitoneally. There were fewer deaths among the immunized mice than among the controls. Mice that did die succumbed primarily between the 5th and 10th days, whether or not they had been previously injected with dead cells. This relative immunization was effective regardless of the route of administration of the killed organisms. Injection of a filtrate from the broth in which the yeast phase had been grown also was effective in producing resistance against lethal challenge. With the present techniques, this resistance is not absolute, in that *H. capsulatum* could usually be found in reduced numbers (varying with the size of the challenge dose) in the ani-

mal tissues. Infection was not completely eliminated, but concentration of the fungus at the site of challenge and in such remote tissues as the spleen and liver was lowered. With a decrease in the number of fungus cells there is a corresponding decrease in local tissue damage. This increased resistance is different from the absolute immunity that can occur, for example, after injection of a mouse with an immunizing dose of pneumococcus.

Separation of Active Immunizing Fraction from the Whole Cell

Attempts were then directed toward the separation of the active immunizing agent from other cellular components. In this regard, it was most important to be absolutely certain whether the cells of the yeast phase had capsules. When Darling[11] first described the organism from tissue sections, he obviously believed a capsule to be present, since he named the organism *H. capsulatum*. With the aid of the electron microscope, E. Ribi and I studied cells of the yeast phase that had been grown in a liquid medium and prepared for examination while still in the logarithmic-growth phase. Under these conditions no capsule was present. When the cells were washed in water, however, the cell wall became swollen and assumed the appearance of a capsule. This swollen cell wall, nevertheless, was not a capsule.

A true capsule was readily visible in *Cryptococcus neoformans* when this fungus was examined directly in the growth medium. It was found that the capsule was readily soluble in distilled water. When suspended in this medium, the capsule disappeared and the cells of both *C. neoformans* and *H. capsulatum* closely resembled each other upon examination under the electron microscope.

When the broth-grown cell of the yeast phase was killed by exposure to ether or 1:5,000 merthiolate and vibrated in a Mickle tissue disintegrator, the cell wall cracked. Subsequent differential centrifugation readily separated the cell-wall fragments from the internal protoplasm. When these two cell components were tested in mice for their immunizing capacities, the cell wall showed much the greater activity. Further studies have been in progress to purify and characterize the antigenic fraction responsible for the increased resistance.

Guinea pigs injected intraperitoneally with equal weights of whole cells, cell wall, or protoplasm produced complement-fixing antibodies to all three. However, when the animals were subsequently challenged with a sublethal dose of living cells, the guinea pigs that had received cell walls showed the greatest booster response in complement-fixing antibodies.

The Nature of the Acquired Resistance

The exact significance of humoral antibodies in the increased re-

sistance is still in doubt, although attempts have been made to correlate precipitins, complement-fixing antibodies, or neutralizing antibodies with the relative immunity. Many of the experiments are difficult to interpret because of their negative nature.

Mice that showed resistance to challenge did not consistently have detectable precipitins, complement-fixing antibodies, or neutralizing antibodies. Guinea pigs with complement-fixing antibodies in serum dilutions as high as 1:256 or 1:512 did not necessarily show increased resistance, as determined by quantitative counts of the numbers of fungus cells in such tissues as spleen, liver, kidney, brain, or lungs. On the contrary, some guinea pigs whose sera contained complement-fixing antibodies in dilutions of only 1:4 or 1:8 showed marked resistance to infection. Therefore, no apparent relationship existed between circulating complement-fixing antibodies and increased resistance to infection.

An important test of the part a humoral factor plays in acquired resistance is afforded by the passive serum-transfer method. This procedure, however, becomes complicated when applied to a chronic infection such as histoplasmosis in mice or guinea pigs. As Rich has indicated,[12] the fact that a disease is a chronic one indicates that the development of acquired humoral resistance in the animal is inadequate for combating the disease. Special care, therefore, must be exercised in the effort to produce immunity by passive transfer. First, recipient animals should be continuously exposed to the immune serum being tested during the period when the infection is becoming established. Second, the serum should be homologous to the recipeint animal in order that the protective effects may not be offset by the development of specific antibodies against the foreign proteins.

We have been unable thus far to induce resistance in mice or guinea pigs by the administration of homologous immune serum. Injection of the serum before, during, and after challenge produced no detectable effect. Whether the proper conditions for introduction of the immune serum have not been attained or whether humoral antibodies are unimportant is not known at present. Experiments similar to those of Raffel,[13] wherein guinea pigs challenged with *Mycobacterium tuberculosis* were treated with immune serum for an extended period, have not yet been completed.

Preliminary *in vitro* studies have indicated the possibility of a cellular mechanism being important in acquired resistance. Washed leucocytes from the peritoneum of immunized guinea pigs phagocytized more fungus cells than those from control animals when similar quantities of mononuclear cells were exposed in Tyrode's solution to a given number of washed cells of the yeast phase in a given period of time.

Resistance to Reinfection

Twenty-one-day-old male mice were inoculated intraperitoneally with

sublethal doses such as 10^6 cells of isolate 6515. Challenge 14 days later with a lethal intracerebral dose produced much fewer deaths than in control animals. In one group of experiments, for example, 239 of 259 (92 per cent) control mice died within 21 days after challenge, whereas only 55 of 246 (22 per cent) previously infected mice succumbed to lethal intracerebral inoculation. This resistance to lethal infection developed in previously inoculated mice regardless of the routes or dosage of the immunizing cells. There was a tendency, however, for the mice inoculated with small numbers of cells of *H. capsulatum* (*i.e.*, about 10 cells) to show less resistance to reinfection than those inoculated with greater numbers of fungus cells when the time interval between the two injections was maintained at 14 days. When an intraperitoneal inoculation of 10^6 live cells was used, resistance to lethal intracerebral challenge did not develop until about 72 hours after the first injection. Maximum resistance was apparent at about five days after the original injection and persisted with little change until at least 35 days later.

In general, previous infection only partially inhibited the growth of the fungus within the tissues. This inhibition, determined by actual fungus-cell counts, tended to be pronounced at the site of inoculation as well as in the liver and spleen. In the spleens of control mice and guinea pigs, the numbers of fungus cells increased for the first two to three weeks (at the sublethal dose-levels used) after injection, and then gradually decreased. However, in the reinfected animals, the fungus did not multiply further. The titers of fungus cells remained at about the same low level in the spleen during the eight postchallenge weeks of observation.

Hypersensitivity after Infection

When immunization with a sublethal dose of living cells was followed 14 days later by challenge via the intraperitoneal instead of the intracerebral route, the mice reacted differently. Instead of merely showing an increased resistance to lethal infection, these mice succumbed in large numbers within 24 to 48 hours after the second infection. Some animals that survived early death due to shock were resistant to the lethal infection during the subsequent days.

This hypersensitive state was not apparent until three or four hours after the second intraperitoneal injection of live cells. At that time the mice appeared sluggish. By six to eight hours after inoculation, some of the mice were dead and many of the others had developed such signs as sluggishness, hyperpnea, and diarrhea. Most of the deaths occurred between the 8th and 24th hours after injection.

These experiments were conducted with a 14-day interval between the primary infecting and the secondary lethal dose. During this interval, mice developed hypersensitivity and resistance to infection.

When the time interval between the two injections was reduced to 24

hours the mice showed neither increased resistance nor increased hypersensitivity. When the interval was 48 hours there was some evidence of increased resistance to reinfection. Resistance to reinfection was apparently at a maximum after a five-day interval, although there were still no signs of increased hypersensitivity. Deaths due to hypersensitivity appeared after a nine-day interval, although there was no detectable change in resistance. Mice were most sensitive to re-exposure to the cells of *H. capsulatum* after 14 days, as shown by the high mortality within 24 hours after reinfection. Thus the time required for the development of resistance was about five days, in contrast to the 9- to 14-day period required for the production of hypersensitivity. The length of the period needed for development of sensitivity could be shortened by increasing the number of fungus cells in the sensitizing dose.

Sensitivity of infected mice could also be demonstrated after injection of 10 to 15 mgm. of acetone-dried cells. Again, about nine days were required after the initial injection before sensitivity could be detected with dead cells.

That death due to hypersensitivity did not follow intracerebral challenge was probably caused by the fact that a subthreshold quantity of fungus cells was introduced. The quantity of antigen necessary to induce a delayed systemic hypersensitive response is apparently large. However, due to the complex antigenic nature of the cells, it is not known exactly how much specific shocking antigen is necessary.

Acquired resistance (as indicated by protection to lethal intracerebral challenge) reaches its maximum detectable level before hypersensitivity (as indicated by fatal delayed shock after intraperitoneal injection of large numbers of fungus cells). Later, the protection of the animal by the immune process may be largely offset by the subsequent development of hypersensitivity. What part antibody plays in these reactions and what relationship exists between acquired resistance and sensitivity are now being investigated.

Summary

Mice and guinea pigs acquired resistance to histoplasmosis after injection of a cell-wall fraction of the yeast phase of *H. capsulatum*, or after a sublethal infection. This increased resistance after actual sublethal infection developed more rapidly than the counteracting hypersensitivity. The nature of the immune mechanism has not been resolved, although it appears that humoral antibody may not form its basis.

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*SECTION OF ANTHROPOLOGY**

AMERICAN CULTURE IN SAUDI ARABIA**

By Solon T. Kimball

Teachers College, Columbia University, New York, N. Y.

Along the western shores of the Persian Gulf in the province of Al Hasa in eastern Saudi Arabia, oil was discovered in 1938. Subsequent exploration and development, most of it since World War II, has established that this area contains the largest proved oil reserves of any country in the world. The development of oil production and processing has been an enterprise of immense magnitude demanding extraordinary skills in many directions. Technical competence has constituted only one aspect of a many-sided problem. The Arabian American Oil Company (Aramco), a consortium formed by four major American oil companies to finance and direct the operation, has found itself involved, directly or indirectly, in international diplomacy, domestic and foreign policy, international monetary and distributive problems, the internal affairs of Saudi Arabia, the need for new financial and managerial organization and, last but not least, the relationships and behavior of mere humans. It is with one aspect of this latter problem, the behavior of Americans in Saudi Arabia, that this presentation is concerned.

The other facets of the situation, however, cannot be ignored, since the shape and style of American life cannot be divorced from the operation, organization, and policy of Aramco, and these, in turn, are related to the ebb and flow of events in Saudi Arabia, in the United States, and on the world scene. The framework within which my observations have been organized and the adequacy of my data are secondary considerations of particular interest to the field anthropologist; hence, a few words about the circumstances that permitted my visit to Saudi Arabia seem in order.

Aramco's Training Department invited me, in the spring of 1955, to participate in their summer institute for teachers of American children. It was planned that I should conduct a one-week seminar in each of the three American settlements and, in addition, give a public lecture in each community. I arrived at Dhahran, the headquarters for company operations, in mid-August and proceeded immediately to Ras Tanura, the location on the Persian Gulf where refinery operations are concentrated. A week later I moved to Abqaiq, an inland town located near the great oil fields. The last week I spent in Dhahran.

In each case, my official host was the school principal and, although my primary contacts were with school teachers, I also had the opportunity to visit plant installations, observe some of the operations, and talk with

*No meeting was held by the Section of Oceanography and Meteorology in February.
**This paper was presented at a meeting of the Section on February 27, 1956.

employees and their families. I received warm hospitality from all. There were numerous informal gatherings where I had the opportunity to learn many aspects of past and current activities. Both official and personal relationships afforded an unusual opportunity to acquire a feel for the style of life, its limitations and opportunities, which American employees experience. Obviously, the three-week visit was far too short to make the kind of detailed study which characterizes anthropological field method. Nor was it my original intention to make such a study or to speak on or publish my experiences. My change of mind came long after my return, and from encouragement by others that, however incomplete, the systematic presentation of my observations could serve several purposes.

In the first place, there is merit in a purely descriptive account of American life in a foreign setting. Then I was impressed, as all must be who see what has been accomplished, with the magnificence of American technological know-how, somehow coupled with the inability to comprehend or, if understood, to deal adequately with problems of human relationships and emotions. Although one may hear frequent praises for the things that Aramco does for its employees and although the phrase "We've never had it so good" is used often, nevertheless, there are deep currents of disquiet and frustration, and perhaps even more serious personal consequences.

An additional and professional reason has contributed to my motivation to write. It is a perfectly sound hypothesis that the kind of social structure that evolves around a great technological operation will resemble similar situations elsewhere. The never-ending search for general principles of human organization based upon comparative examination of life forms is a central goal of the anthropologist. I was stimulated to think that what I observed might be an emergent community form and that, if so, its structure and consequences should be recorded. This thought occurred in the context of another. There is no reason why we, and I use the word we here to include the peoples of all cultures, need to live in cultural settings that do not provide a maximum of human satisfactions. Obviously, each situation provides limitations that shape the nature of the social system that operates within it, but these are seldom so stringent as to prevent the ultimate realization of human aspirations. The deficiency appears because of our own inadequacies. Thus this analysis might serve to increase our awareness of the relation between social environment and human behavior, and to suggest ways in which remedial measures, if needed, might be taken.

Finally, over and over again, I was struck with the feeling that I was witness to American characteristics exposed in bold relief. My own interest in the American scene has frequently led me in search of answers to the elusive question, "What is an American?" I believe that my experience in Saudi Arabia has deepened my perception of what our

basic values may be. It may also have served to indicate the kind of world in which an increasing number of Americans may expect to live and the kind of adjustments that will be expected from them. I recognize, of course, that a more systematic and longer examination is necessary before it is safe to accept any conclusions, but these observations may serve as an inspiration to further study. It is now time to turn to the substance of this report and to summarize briefly the physical and cultural seeting within which a tiny outpost of American civilization has been dropped.

The Setting

Aramco's operations are centralized at three main settlements, Dhahran, Ras Tanura, and Abqaiq, with a combined population of over 20,000. The headquarters town of Dhahran contains nearly 10,000, the other two claiming about 5,000 each. Employed personnel number 20,400, of which 3,000 are Americans, 13,400 are Saudis, and 3,000 are other nationals. When one counts the family members of American personnel, the total number comes to 6,400 persons, or about one third of the whole.

Twenty years ago the sites that these towns now occupy were covered with sparse vegetation characteristic of the desert and utilized only by wandering *Bedu* with their flocks of sheep, goats, and herds of camels. Two of these towns have appeared in the last decade, and it is now proposed that another will rise as oil operations expand.

Each town is divided into five distinctive sections that correspond to internal social divisions or economic functions. The vibrant heart of the town, although not centrally located, is the administrative, operational, and service district. It is here that one finds the offices, warehouses, supply depots, equipment yards, repair shops, and the vast array of towers, tanks, and pipes that are necessary for the processing, refining, and transmission of oil. It is within this area that one can also find the major retail and service centers, that are reserved for use by the "senior" staff, a group composed largely of Americans but with a scattering of other nationalities. Here, one may buy stamps and post a letter, get a haircut or a beauty treatment, buy groceries, household supplies, and essential personal items. All these activities are directly supervised by Aramco.

The four other areas are residential, each separated from the other by either space or some other type of barrier. The divisions correspond closely with the structure of the bureaucratic hierarchy and ethnic divisions among the employees, a correspondence which gives emphasis to the social divisions within the whole.

No Westerner would have difficulty in identifying the senior staff "camp" as a settlement built by Americans in our southwestern tradition of town planning. It is an area of single-story dwellings for employees

and their families. Each house is surrounded by a small grassed yard usually enclosed by a hedge. There are other plantings including flowering shrubs, low desert trees and, in some instances, flower gardens. Only in Dhahran is there a variation on the grid pattern of streets and walks. Here one finds a few curving streets and irregularly shaped blocks. Streets are paved and frequently curbed, and have night lighting. There are only slight variations between the recreational facilities of each senior staff camp. Each one possesses an auditorium that is also used as a movie theatre and for amateur productions; a luxurious club with snack bar, bowling alleys, library, dining room, lounge, and terrace for dancing and social gatherings. Two senior staff camps have swimming pools, while Ras Tanura residents may use an immense beach on the Persian Gulf. In addition, one may find baseball diamonds, tennis courts, soccer and football fields, and desert-style golf links. Dhahran has a riding stable.

There is some variation in size and construction of habitations. The "unclassified" officials, those found in the upper echelons of the bureaucracy, occupy the larger and most elaborate residences. Lesser employees live in more modest quarters. The more fortunate single men and women live in multiple-roomed modern house-type buildings that include space for preparing meals and entertaining. The "bachelors," a term applied to all single men including those with families in the United States, may live in barrack-type structures which, however, have many conveniences. Because of a shortage of family-type housing, a system of assignment based primarily on seniority has been developed.

Each senior staff camp possesses new modern elementary junior-high school buildings that provide facilities for instruction through the ninth grade. There is a well-staffed and well-equipped hospital in Dharan which serves all employees, and there are medical clinics in the other two towns. One feature of American community life that is conspicuously absent is the church building, and more will be said of this later.

Since we are primarily concerned with American behavior, a brief description of the other three areas will suffice.

The "Intermediate" camp houses those employees who are rated in the personnel system as primarily semiskilled and nonsupervisory. The bulk of these are other "nationals," that is, they have been recruited from most countries of the Middle East and some from Africa and the Mediterranean. They include Indians, Pakistanis, Sudanese, Adenese, Palestinians, Lebanese, Italians, *etc.* The barrack-type dwellings are permanent concrete or cement-block structures.

The camp for "general" or "Saudi" employees is of similar construction and arrangement. Like the Intermediate camp, it has modest recreational facilities, a market for buying foodstuffs and other items, and one or more mosques. Unlike the Intermediate camp it does not have

facilities for showing movies, a lack imposed because of governmental restrictions. Both areas are constructed to house only bachelors.

The last residential area is one that was neither planned nor welcomed. To Western eyes it is reminiscent of the Hoovervilles of depression days. Houses have been constructed of every conceivable kind of scrap material with a scattering of more traditional palm-leaf native *barastis*, and an occasional substantial building of concrete block. These settlements represent the attempt by Arabs to establish a type of community life with which they are familiar. Here the employees, mostly Saudis, may bring their families. One can see occasional sheep, goats, and burros, and the camels tethered nearby may belong to an employee or his visiting relatives. One also finds an incipient native *suk* or market, perhaps a garage and gasoline pump, and other evidences of an emerging indigenous community life. Both Aramco and the government are disturbed by these settlements, and efforts are under way to encourage their replacement by the development of planned Arab-type towns through subsidies and other devices.

This brief sketch portrays the physical arrangement of the towns that Aramco built. Their internal divisions reflect the bureaucratic structure of an American corporation, divisions that are sharply accentuated by the coincidence of status levels and national origins. Only in the fringe natural community of the Arabs has there been thus far an escape from planned arrangement. Within the planned community one observes that managerial and technical know-how gives to the American a position of pre-eminence reflected in symbol and fact. It is also, however, a position that imposes a high degree of cultural isolation, some uncertain restrictions upon his behavior, and contributes to an omnipresent sense of precariousness. In order to understand better these other aspects, it is necessary to examine briefly Arab culture and the policies of the Saudi Arabian government as they impinge upon American employees.

Cultural Restrictions

When King Ibn Saud first negotiated his concession with American interests for oil exploration and development in 1933, he had only recently consolidated his hold over the perennially feuding tribes of Arabia. The Arabian peoples had remained singularly untouched by Western technologic or cultural impact. The interior and eastern provinces exhibited a way of life that, with the exception of the great Arab renaissance in the centuries following the appearance of Mohammed, had remained practically unchanged since its first appearance before the time of Jesus of Nazareth. The population of coastal and oasis towns preserved a symbiotic relation with the Bedu pastoralists of the deserts.

The Arabs possessed substantial cultural homogeneity in their traditions, language, and adherence to the Moslem faith. But there were also

divisive forces within them based upon differences of oasis and pastoral economy; regional, tribal, and family loyalities; and religious sectarianism. The basis for a homogeneous nation was present, but it needed the organizational genius of a man like Ibn Saud to weld the warring factions into some semblance of cohesiveness. In his drive for power, however, he relied heavily upon the support of the Wahhabi, a fanatical puritanical sect suspicious of the outsider, reactionary in its rejection of cultural innovation, and demanding strict adherence to a narrow interpretation of Islam. This group has remained loyal in support of King Ibn Saud's regime and is a constant threat and terror to dissidents. The extent of Wahhabi influence on internal policy is not known, but a plausible explanation has been offered that some of the restrictions imposed by the Arabian government on Aramco employees can be traced to this streak of puritanical chauvinism. It is characteristic that new decrees are issued without previous warning and are thought to be unpredictable and capricious. Since I do not know the other side of the story it is entirely possible that the Saudi government views its own actions as most considerate and generous, considering all the circumstances under which it must operate.

In any event, there are certain restrictions placed upon American behavior that are contrary to American habit. These restrictions provoke frequently expressed anxieties that further repressive measures may appear or that certain types of punitive action may be imposed upon individuals, and perhaps on Aramco. This is one of the aspects that contributes to feelings of impermanence and precariousness. The employees look to the high officials of Aramco to provide them protection, although they are also aware that certain breaches of law mean immediate deportation, a fate viewed more favorably than languishing in an Arab jail. It is not that the restrictions are particularly onerous, they are merely expressive of the fact that the American is in a situation where he cannot control all the variables and where he is uncertain of the way the forces operate. Let us examine some of these restrictions.

The Moslem code imposes certain prohibitions upon its adherents. In particular, there are dietary laws, views about costume, a demand for strict abstinence from alcohol, requirements for daily worship, fasting periods, and objection to representation of the human figure. In addition, the government itself is highly sensitive to criticism. Finally, there are the ancient systems of law and justice, based upon an Arab-Moslem tradition, that are quite alien to those who know only the Anglo-Saxon tradition. These are cultural differences that can lead to considerable misunderstanding, and it is to the credit of the Saudi government and Aramco diplomacy and employee behavior that there have been no serious disturbances. However, let us see precisely how the imposition of Arab values may affect the American situation.

Up until about two years ago there was no restriction upon the importation of hard liquor and beer for use by American employees. This privilege was abruptly canceled (according to folklore or fact because of an unfortunate incident involving a British diplomatic couple and as a sop to Wahhabi sentiment) with the attendant threat that violation of the decrees against alcohol would lead to jail, deportation, or both. This restriction seriously disturbed the customary behavior of a great many people. American men who engage in hard outdoor labor are known to relish an evening's beer or more, and the oil field workers have always been respected for their capacities. I heard several lament the passing of beer in particular. These employees recounted the many pleasant evenings when large numbers would congregate at the clubs to visit, gamble, or dance. They complained that soft drinks never quite provided the same spirit of conviviality, and they regretted the passing of, to them, pleasanter days of good companionship. Drinking became limited to smaller intimate groups where there was less fear of indiscreet comments. Americans who had previously lived under their own prohibition laws showed the same qualities of ingenuity and self-justification that had characterized an earlier period of American history. Nevertheless, the danger was great and behavior correspondingly circumspect.

Contraband included weapons, certain publications, and, at one time, it was reported that dolls were confiscated. The government frequently bans a particular issue of a magazine or newspaper because of its critical treatment of the Saudi government. There are no public moving picture houses in all Arabia. Films are shown in the senior staff camp, although Saudis are excluded, and the government undoubtedly has the right to cancel further showings if it so desires. Television sets are also banned.

These restrictions extend to the work relationship. American supervisors must never interfere with the exercise of religious expression by an Arab. Americans are also cautioned to avoid body contact, including expressions of friendliness, since these might be interpreted as assault. Nor did the employees with whom I talked feel that they could punish inefficiency or other dereliction by reprimand or by any other penalty. As one said to me, you "keep your eyes open and your mouth shut." One is told that the result of this condition is greatly lowered productivity. On the other hand, most Americans praised the loyalty, intelligence, and accomplishments of their Arab workmen, and the fact that more and more difficult technical operations are being turned over entirely to Arab crews is proof of their increasing technical skills. This, too, is a threat to the less-skilled American employees for, as Arabs are trained, there will no longer be a need for their services. Finally, Arab women are absolutely taboo. This is one area in which the American male seems to have observed a rigorous abstention. Not only are the opportunities for

sexual play extremely limited, but there is always the threat of immediate and drastic reprisal by aggrieved male relatives upon the offender.

These, then, are some of the cultural conditions that impose upon freedom of behavior. They are not drastic, but oil towns have something of the spirit of the frontier about them, and these restrictions are not favored by untrammeled spirits. The situation intensifies relationships within the American group, since the kind of conviviality through which they might establish bonds with Arabs is denied to them and also alien to most Arabs. This, then, leads us to the examination of the American world itself.

American Cultural Characteristics

It would be difficult to find any other organization that offers as many advantages to its employees as Aramco. The salary schedule is substantially higher than comparable stateside jobs. One's income is free from United States taxes, although subject to a modest Saudi deduction. The company provides generous payments toward retirement that may be realized after 20 years service or at the age of 60.

Education for children through the ninth grade and many recreational facilities are free, but employees must pay for health care of their families. There is a living allowance, in addition to salary, that covers the rent for quarters and some to spare. The basic necessities are sold through company stores at prices comparable with stateside and probably includes a large subsidy by the company. Each employee receives a two-week vacation at the end of his first year and a two and one-half month vacation at the completion of his two-year contract. The company will pay him the equivalent of his transportation and expenses to the United States, but there is no requirement to return home, and desire alone determines his travel plans, except that he must leave Saudi Arabia. Import duties and shipping charges into Saudi Arabia or the United States on a specified list of household goods are all paid for him. Families with children of high-school age receive tuition and three round trips per year on company planes for those attending an American high school in Beirut, Lebanon, 1000 miles away. The company is anxious to recruit and hold able employees, and it provides incentives through additional free education and opportunities for advancement. Living conditions are as good as money can buy with all buildings air-conditioned and suitably furnished.

One could enumerate many additional perquisites and considerations that accompany employment and living, but the list is sufficient to warrant the oft-heard phrase, "We've never had it so good." Aramco follows a policy of benevolent paternalism partly dictated by the conditions of the situation. But while material well-being, security, and

opportunities for cultural expression have all been achieved, somehow, Utopia realized is far less attractive than as a hope.

When one begins to probe beneath the surface attractions, it is not difficult to discover manifestations of discontent, anxiety, and frustration. Even those having a perspective of the contribution of American technical development and a sense of mission are prone to lapses of pessimism. The outstanding positively affirmative statement one hears is "I'm here for the same reason as everyone else—the money." Even this advantage is viewed in a context of adverse sentiments such as "It isn't like home," "It's a lot of nothing," to more analytic comments such as "Americans don't like to have everything done for them," to the ultimate declaration, "I've had it, I quit." Interestingly enough, the impression of impermanence is contradicted by an employee turn-over rate that is lower than that for the United States industrial average. Perhaps adverse comments are a safety-valve for those who renew their contracts each two-year interval and who find their situation an adequately satisfying one. Perhaps they do not have the feeling of being "cut off" or of regimentation, or perhaps the rewards, present or anticipated, outweigh other considerations. And, of course, there is a selective process that keeps those who make an adjustment and like their jobs. Any thorough analysis would need the quantitative statement of employment characteristics, as well as an adequate sample of life histories, to understand both the gross and individual similarities and differences that appear. Although these were not obtained, description of the generalities of behavior within the cultural setting will suit our purposes.

The Female World

Anthropologists are aware that the adult female, by virtue of her position as wife, mother, and homemaker, embodies, expresses, and preserves the basic values of the culture to a greater degree than does the male. Her role enables her to mold the emotional life and to shape the normative outlook of the developing child. Thus, her function is crucial to the stability of a social system and to the cultural transmission of its values and practices from generation to generation. Thus, any situation that impairs the full expression of femininity is a threat to the basic values of the woman and has its implications and repercussions in other aspects of the system. When we come to examine the status of the married female in the company-built and company-organized communities, we discover that the securities of an American-type community are only partially realized and that the deficiencies militate against the woman.

The oil industry is a man's world, and the production of oil under frontier conditions is not favorable to the establishment of stable family and community relations. Aramco's decision to provide family housing was in large measure dictated by the harsh reality of providing an en-

vironment in which some greater stability of personnel might be achieved. Whatever the complications, a community without women is bleak indeed. Today, two thirds of the 2,700 American male employees have their families with them, but in Saudi Arabia, community life is secondary to the primary goal of oil production.

Married American employees do not arrive at Aramco's installations with their families. They come singly, to be followed in from six months to two years or more, depending upon availability of housing, by wives and children. During this period of enforced separation the male, mostly by force of circumstances even if the choice were otherwise, finds himself isolated from female companionship. Ordinarily he has been under considerable pressure from his wife, which, combined with his own inclinations for his family to join him, causes him to bring pressure upon the system that controls house assignments. He is overjoyed when arrangements are made for his family to join him.

The newly arrived American woman enters a world that contrasts greatly with the one she has left. The house she occupies has been furnished with standard items from the warehouses. She has had the opportunity to ship her own things, but these may arrive weeks or months later. In the meantime she nest-builds the best she can and, after she has acquired friends, she can resort to what is locally called "moonlight requisitioning," a process by which women get their husbands to transfer agreed-upon pieces of furniture among themselves, after dark. Such activity results in considerable confusion when record clerks attempt to straighten out official property records, but women accept the sanctity of such lists with considerably less awe than their keepers.

The food situation can also become troublesome at times. The seemingly unlimited supply of groceries stocked by an American supermarket can hardly be duplicated by Aramco purchasing agents who attempt to buy as much as possible from sterling bloc countries. Also, shipments may be delayed. The housewife sometimes finds it difficult to get either the variety or quality of items to which she is accustomed. For those who have never questioned the bountifulness of the American grocery, these deficiencies may seem irritations that can grow into hostilities when the housewife is forced into competition with the single female employees for hard-to-get items. From all reports she faces almost no competition from the same source for the affection and attention of her husband. This security results in a hold on her spouse seemingly greater than in a comparable American community.

The household chores are not onerous. Many families employ Arab or Indian house boys and Arab yardmen. The former, especially Indians, are trained to do a full range of house work, and many of them do much of the cooking. The living allowance helps meet the cost of servants who seem to be employed more as a matter of status than of necessity.

Activities outside the house can be as full and varied as the woman chooses. It would be difficult to think of any interest that is not provided for in the organized recreation and club programs. She can bowl, swim, play tennis or golf, join music appreciation groups, discuss great books, square dance, take lessons in bridge, dancing, household activities, child care, and nursing, or she may just stay in her house and do nothing. Like her husband she has little opportunity for civic responsibility and a great deal of freedom for self-improvement. Reports indicate, however, that most wives join their husbands in tight little friendship groups of a few couples who gather on week-ends and, occasionally, at other times for social purposes. There are some who are inveterate afternoon bridge players, but mostly within the same group. Casual observation indicated a high degree of correlation between the husband's position on the bureaucratic ladder and one's off-the-job associates. Under such circumstances the efforts of social climbing by the wife would be relatively fruitless unless confirmed by her husband's promotion. The amount of influence that the woman can use to help advance her husband is a problem of considerable interest but there is not much evidence of it. It would seem that factors over which she has no control are more significant for her husband's status.

Religious and educational aspects should also be mentioned. Her children must go away for high school and college education. Separation from the joys and responsibilities of her adolescent children may force readjustments. Some women have returned to the United States rather than give up their children, and the husband must either change jobs or remain behind. Although there is freedom of worship, and although organized religious groups hold regular services, freedom of religion is not exactly the same as in the United States. For one thing, the work week follows Islamic custom, which puts Sabbath observance on Friday. In general, the institutional aspects of religion are minimized, and the church-oriented woman finds little to meet her needs.

Previous experience and personal factors must play an important role in the over-all adjustment that American wives make to life in Arabia. The impermanent situation, the relative instability and narrowness of social relations, and restrictions on movement and activity, must give some substance to the belief that married women have a difficult time. Of course, those who find the life a satisfying one, or who possess capacities for adaptability complain less often. The possibility that it is a fad to complain about the conditions should not be dismissed, but there are distress signals that all is not well.

It is unnecessary to devote as much time to the other categories of the population since the general conditions under which they live have already been described, and some of the specific aspects attributed to married women apply to their husbands and, to a lesser extent, to the

unmarried male and female employees. No attempt will be made to describe child life, other than to say that children can lead an active outdoor life, have good educational and recreational facilities available to them, yet are limited in the range of social experience that the cross section of an American community would provide. One can hear occasional criticism of youthful behavior mostly in reference to exuberance and monopolization of recreational facilities. Some teachers felt that young people were overorganized and did not have enough opportunity for activities generated on their own initiatives. The impact on youth deserves careful study, and my own observations were too limited to make any constructive comments.

Although single female employees number only 300, they offer an important segment for contrast. They occupy the traditional occupations of teaching, nursing, stenography, and clerical positions, and they are barred by tradition and fact from field and administrative posts. Unlike males, the opportunities for job mobility are practically nonexistent. Quite a number have had previous foreign experience, and there are those who had decided upon continued careers abroad, though not necessarily with Aramco.

Their adjustment to Aramco life would be more meaningful if we knew more of their backgrounds and motivations. There is a widespread male belief that most came in pursuit of a potential husband. This is a commonly attributed aspect of female behavior, and it is doubtful if many would deny its importance. But there are also other reasons, many of which resemble those of the male. There are those who are running away from something. Others have romantic notions of adventure and travel. And for some, money is a major or added incentive, but for reasons quite different from those of the male. Money is viewed in terms of its usefulness to permit travel and the purchase of clothes and luxuries. The male views money saved as a stake for his family security or for some future enterprise.

The social adjustment and, in particular, the sexual behavior of the single female employee is the subject of a great deal of interest, talk, and speculation. Since there are three "bachelor" men for each woman, the situation would appear to be heaven-sent for the male-interested woman. The extent of male interest is reflected in one story that, in an earlier period, numbers of "bachelors" greeted every incoming plane with new personnel from the United States for the purpose of scrutinizing the arriving female contingent. Any assumption that mere numbers of available males guarantees female happiness is quickly dispelled by frank and sometimes caustic analyses of male behavior. When direct questions were asked about the apparently unusually favorable situation for romance and husband-hunting the often-received reply was, "But have you seen what we must choose from?"

One newly arrived and romantically disillusioned young woman presented a classification, perhaps over-neat, of her observations. She explained that there was a large group of men, both young and middle-aged, who exhibit no romantic inclinations. The married group of "bachelors" includes those who avoid female companionship and others who are aggressive but need to be repelled because of their obvious fleeting intentions. The female-oriented eligible males may also be divided into several groups. Some of these were placed within the "wolf" category. These are quickly spotted, and informal channels of communication spread the word about their behavior and intentions. Other eligible males have their real interest in the girl they left behind, leaving a very small residue, the best of which, this young lady sadly explained, had already been claimed.

It would appear, however, that most of the single women have formed more or less permanent cross-sexual liaisons. This pair relation may be extended to include other similar couples that join together in recreation and week-end conviviality. The content of their informal conversations resembles the married couples in exchange of information about the operations of Armaco and in discussing contemplated or already experienced short and long vacations.

Vacations are events of great importance in the life of the single female. Unspent salary permits extensive traveling, sometimes around the world, before they return to their jobs, and the opportunity to visit shops that sell fashionable clothes and other items of elegance and luxury. For the first few days after their return, the new possessions are shown and experiences are recounted, and then there is the return to the familiar round of acquantances and activities. Or, there is the alternate likelihood that the employee will not return at all but will remain in the United States or find another foreign post that seems to offer more. Very few, indeed, are successful in finding husbands. Surprisingly, the resignation rate is only one third that of males.

Single women find little in common with their married sisters. They are separated by status and condition, and the division is confirmed in their respective associations and activities. Each seeks her own kind for leisure-time events, each has access to a different kind of male world, and both are barred from Arab contacts except through the American male. It is to this latter group that we now turn.

The Male World

It may seem curious that we have delayed the description of male behavior to the end. This is not a result of a cultural bias that gives precedence to the ladies. On the contrary, the order has been determined by the situation in which the activities of oil technology, management, finance, and diplomacy are primary and exclusively male. In contrast,

family and community are secondary and are, in reality, complicating and disturbing elements to the main objective. The dramatic and impressive aspects of Aramco's operations are seen in the complicated technical and human organization through which oil is extracted and processed. The other activities, however necessary, appear as synthetic reproductions of American community life. Although the dynamics of industrial organization portray the genius of American success, their full description can be realized only through systematic and long-term study. Our goal is the much more modest one of examining some of the human characteristics of the actors.

The American male employees of Aramco may be grouped in several ways. Job status and marital condition are categories of immense significance. The former determines salary and other perquisites, but both affect the conditions of living and of on-and-off-the-job associations and activities. The general outline of the bureaucratic divisions are known to everyone. The "senior" staff, with only a handful of nationals other than Americans, sits atop the status pyramid, and no American is found in intermediate or general grades. This general preeminence correlates with the concentration of skills that are necessary to a complicated operation. Although the spread within the American group is very great indeed, even the lowliest has evidence of his superiority and a sense of commonalty. The financial rewards are relatively great, security is guaranteed, and the necessities for existence are more than adequate.

There are many aspects that resemble the frontier. Although no man can make a monetary success on his own initiative, the lesser goal of acquiring a stake stimulates many to return at the termination of each two-year contract. Male pleasures of gambling, liquor, and sometimes fighting were more widely enjoyed in earlier years, but may still be found. The easy female companionship of the frontier town is lacking, but journey by air to the sophisticated hot spots of Middle Eastern cities is less time-consuming, although more expensive, than the monthly visit to the "cow town." There is, however, one overpowering and crucial difference. The paternalistic control of Aramco reaches into every nook and cranny of one's life and gives a security that actually contributes to the feelings of impermanence and precariousness. What is given may be withheld or taken away.

The world of work belongs to the male. From it he receives the rewards of money and status. With money he can plan the leisures of retirement or greater fortune through investment and enterprise. These dreams would probably be his if he had never left his native state, but in Saudi Arabia they become the subject of open conversation with one's associates and can lead to grandiose schemes of empire or, perhaps, to hopes for orderly repose. Home is a symbol of great power. Arabia represents a self-enforced exile that neither promises permanence nor in which there is any desire to remain.

There are great differences, of course, within this group. Those who occupy the top managerial positions, the "unclassified" in personnel chart jargon, must face complicated problems of world-wide import. They give expression to the political implications of their assignment and its relation to the fate of Western civilization. They view themselves as cultural ambassadors of a powerful tradition and hold a sense of mission. To some extend they exercise control over the world within which they operate.

It is within the middle and lower levels that insecurity of a more personal kind is expressed. There are the older men who have been pushed upwards, perhaps beyond their capacities, who have hopes of finishing their time of service. One finds the frustrated who have failed in their desire for status, or those who remain in the struggle and receive each advancement as signs that the way ahead has not been blocked. Then there are the younger men who have not yet been committed and view their position as a temporary interlude to a stateside career. The contrast with other American corporate behavior is not one of kind but of the intensity and sharpness with which the goals of success are defined. There is a curious contradiction, however, about which some comment should be made.

Within the bachelor group, which numbers slightly over one thousand, there is a contingent that stays almost entirely to itself. These men do not enter into competition for favors from such few single women as are available, nor do they take part in community enterprises. Their companionship is found among other males in simple pleasures of cards, talking, or movies. They appear to be nonsexual, noncompetitive, and nonmobile, and they present a marked contrast to the others. More needs to be known about this type to understand what part of American life it represents, but it also seems to be a type which the frontier attracts.

Irrespective of background or status, the conditions shaping each man's activities show great uniformity. Early each morning the blast of a siren announces the start of a new work day. Workers in air-cooled offices, shaded sheds, or under the open sun begin their varied tasks. The ultimate goal is to speed the flow of oil to an industrial civilization. The noon break and the day's end are also marked by the siren's blast. It is at the end of the work day that married men join their families, while single workers return to their quarters or gather in the dining halls. Late afternoon and evenings are the times for leisure, and each one chooses according to his own inclinations. Only the week-ends, Thursday afternoon and Friday on our calendar, provide a variation in the sequence to be followed by the start of the new week on Saturday. The repetitive nature of each day, week, or month should not be equated with industrial monotony. On the contrary, the world of work is a dynamic and changing one that provides an absorbing environment of ever chang-

ing problems. It is accompanied by frustrations and disappointments, to be sure, but compensations are to be found within activity itself. If anything, restlessness, boredom, and discontent are associated with leisure. The plethora of community facilities does not seem to provide a purposeful and absorbing interest.

Conclusion

There were several dominant impressions that I carried with me upon my departure from Saudi Arabia. Foremost among these was an appreciation of the magnificence of American technical competence and the related ability to create and operate a complicated organizational structure. One could observe the almost exact correspondence between this structure and that of the internal divisions of the community. The paternalistic effort produced an almost ideal variety of community facilities, but the substance of community life, however, seemed distorted and a little unreal. Certain aspects of American character were exaggerated and, in particular, the traditional female role appeared difficult of realization while, for the men, concern with status and money was primary.

The sum of these impressions was to leave one with mixed feelings of admiration and disquiet. One could exult that man has really gained mastery of his physical environment, but there were disturbing doubts that this power was being directed toward human ends. Is it desirable or necessary that community life be a mirror image of bureaucratic structure? Is it possible for viable human groupings to survive if individuals are subordinated to the requirements and direction of an organization serving technical ends? Do we find here the prototype of the community of the future, or, perhaps, have we been witness to the microcosmic distillation of our modern community stripped of its unessential inheritances from an agrarian past? Perhaps we have been concerned with a variant of the company town or military post, themselves possible forerunners of a new kind of human grouping. In any event, we are not dealing with the traditional American community with its dynamics based upon the dispersion of power through institutional equilibrium. American life in Saudi Arabia operates within rational contrivings and, as such, it deserves to be studied and understood.

CONFERENCES HELD

SECTION OF BIOLOGY

SECOND

TISSUE HOMOTRANSPLANTATION CONFERENCE

Thursday, February 2 and
Friday, February 3, 1956

Conference Co-Chairmen:
John Marquis Converse, New York University College of Medicine, New York, N. Y., and
Blair O. Rogers, St. Barnabas Hospital, Newark, N. J.

THURSDAY, FEBRUARY 2, 1956

GENETICS, PHYLOGENETICS AND ACQUIRED TOLERANCE

Session Chairman: Nathan Kaliss
Roscoe B. Jackson Memorial Laboratory,
Bar Harbor, Maine

9:00 A.M. –
Greetings from the Academy – Hilary Koprowski, Chairman, Section of Biology, The New York Academy of Sciences, New York City; Lederle Laboratories Division, American Cyanamid Company, Pearl River, N. Y.

Introductory Remarks – John Marquis Converse, New York University College of Medicine, New York, N. Y.

"The Genetics of Skin Grafting" – E. J. Eichwald and C. R. Silmser, Montana Deaconess Hospital, Great Falls, Mont.

Discussion: George D. Snell, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

"Scale Homotransplantation in Goldfish (*Carassius auratus*)" – W. H. Hildemann, Kerckhoff Laboratories of Biology, California Institute of Technology, Pasadena, California.

Discussion: Myron Gordon, N.Y. Zoological Society, New York, N.Y.

"Induction of Acquired Tolerance in Rats Shortly After Birth" – M. F. A. Woodruff, University of Otago, Dunedin, New Zealand.

Discussion: Rupert Billingham, University College, London, England.

"Studies on Epidermal Cell Suspensions with Particular Reference to Problems of Tissue Transplantation Immunity" – Rupert Billingham, University College, London, England.

Discussion: Morris K. Barrett, National Cancer Institute, Bethesda, Md.

"Implantation of Functional Erythropoietic Elements Following Total Body Irradiation" – Dan L. Lindsley, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Discussion: Hilary Koprowski, Lederle Laboratories Division, Pearl River, N. Y.

Panel Discussion

Rupert Billingham — Raoul M. May
E. J. Eichwald — George D. Snell
Hilary Koprowski

CELLULAR ANTIBODIES, SERUM ANTIBODIES AND DELAYED HYPERSENSITIVITY PHENOMENA

Session Chairman: Lewis Thomas
New York University College of Medicine,
New York, N. Y.

2:00 P.M. –

"Similarities Between Homograft Rejection and Tuberculin-Type Allergy (A review of recent experimental findings)" – H. Sherwood Lawrence, New York University College of Medicine, New York, N. Y.

"Passive Immunity Against Mouse Leukoses with Iso-immune Sera" – D. B. Amos, Roswell Park Memorial Institute, Buffalo, N. Y.

"The Problem of Specific Inhibition of Antibody Synthesis in Adult Animals by Immunizing the Embryos" – Melvin Cohn and Rita Levi-Montalcini, Washington University, St. Louis, Mo. (Read by A. M. Pappenheimer, Jr., New York University College of Medicine, New York, N. Y.)

"Production of Delayed Sensitivity to Protein without Detectable Circulating Antibody" – J. W. Uhr, S. B. Salvin, and A. M. Pappenheimer, Jr., New York University College of Medicine, New York, N. Y.

"Skin Homotransplantation Studies in Agammaglobulinemic Patients" Robert A. Good, University of Minnesota Medical School, Minneapolis, Minn.

"The Demonstration of Delayed-Type Reactivity in Congenital Agammaglobulinemia" – Herbert Porter, Lenox Hill Hospital, New York, N. Y.

Panel Discussion

Merrill W. Chase A. M. Pappenheimer, Jr.
Rupert Billingham Guy Voisin
H. Sherwood Lawrence

FRIDAY, FEBRUARY 3, 1956

EMBRYONAL, ADULT AND TUMOR TISSUE HOMOTRANSPLANTS

Session Chairman: Herbert Conway
Cornell University Medical College, New York, N. Y.

9:00 A.M. –

"The Possibilities of Embryonal Transplants" – Raoul M. May, University of Paris, Paris, France.

Discussion: M. J. Kopac, New York University, New York, N. Y.

"Studies on Kidney Homotransplant Rejection Using a Cross-circulation Technique" – Richard H. Egdahl, University of Minnesota Medical School, Minneapolis, Minn., and David M. Hume, Harvard Medical School, Boston, Mass.

Discussion: Benjamin B. Kamrin, State University of New York, College of Medicine, Brooklyn, N. Y.

"The Relation of Hair Cycles to the Duration of Survival Time of Skin Homografts in Rats" – Donald L. Ballantyne, Jr. and John Marquis Converse, New York University College of Medicine, New York, N. Y.

Discussion: Peter Randall, University Hospital, Philadelphia, Pa.

"Prolonged Survival of Skin Homografts in Uremic Patients" – Gustave J. Dammin, Joseph E. Murray and Nathan P. Couch, Harvard Medical School and Peter Bent Brigham Hospital, Boston, Mass.

Discussion: Blair O. Rogers, St. Barnabas Hospital, Newark, N. J.

"The Survival of Tumor Homografts in Mice Pretreated with Antisera to Mouse Tissue" – Nathan Kaliss, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Me.

Discussion: Rupert Billingham, University College, London, England.

"Immune Phenomena Elicited by Transplanted Tumors: Cytotoxic Effects of Immune Guinea Pig Sera to Mouse Cancer Cells" – O. N. Rambo, Jr. and Roger B. Fuson, Veterans Administration Hospital, Salt Lake City, Utah, and University of Utah College of Medicine, and E. J. Eichwald, Montana Deaconess Hospital, Great Falls, Mont.

Discussion: Glenn H. Algire, National Cancer Institute, Bethesda, Md.

"Chemical Studies on the Enhancing Factor: Effects of Organic Solvents, Oxidizing Agents and of Certain Enzymes" – Andrew A. Kandutsch, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Me.

Discussion: Henry Winn, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Me.

LYMPHOCYTES, LYMPH NODES AND HOMOTRANSPLANTATION

Session Chairman: E. J. Eichwald
Deaconess Hospital, Great Falls, Mont.

2:00 P.M. –

"Studies on Tissue Homotransplantation in Mice Using the Diffusion Chamber Technique" – Glenn H. Algire, James M. Weaver and Richmond T. Prehn, National Cancer Institute, Bethesda, Md.

"Use of Millipore Membranes in Studies of Skin Homografts" – M. F. A. Woodruff, University of Otago, Dunedin, New Zealand.

Discussion: Glenn H. Algire, National Cancer Institute, Bethesda, Md.

"The Response of Regional Lymph Nodes to Skin Homografts" – R. J. Scothorne, University of Glasgow, Glasgow, Scotland. (Read by Blair O. Rogers, St. Barnabas Hospital, Newark, N. J.)

Discussion: Robert A. Good, University of Minnesota Medical School, Minneapolis, Minn.

"Studies on the Homotransfer of Suspensions of Lymph Node Cells" – T. N. Harris and Susanna Harris, Children's Hospital of Philadelphia and University of Pennsylvania, Philadelphia, Pa.

Discussion: H. Sherwood Lawrence, New York University College of Medicine, New York, N. Y.

"Resume of the Evidence of the Role of Antibodies in the Rejection of Homotransplants" – Guy Voisin and P. Maurer, Hospital Saint Antoine, Paris, France.

Discussion: Byron H. Waksman, Department of Bacteriology and Immunology, Harvard Medical School and Massachusetts General Hospital, Boston, Mass.

"*In Vitro* Studies on Cell Injury in the Tuberculin-type Reaction: Implications in Homotransplantation" – C. B. Favour, Palo Alto Medical Research Foundation, Palo Alto, Calif.

Discussion: Chandler B. Stetson, New York University College of Medicine, New York, N. Y.

STAPHYLOCOCCAL INFECTIONS

Thursday, February 16 and
Friday, February 17, 1956

Conference Chairman: David E. Rogers
Cornell University Medical College, New York, N. Y.

THURSDAY, FEBRUARY 16, 1956

HOST FACTORS IN EXPERIMENTAL STAPHYLOCOCCAL INFECTIONS

Session Chairman: Rene J. Dubos
Rockefeller Institute for Medical Research,
New York, N. Y.

9:00 A.M. –
Greetings from the Academy – Hilary Koprowski, Chairman, Section of Biology, New York Academy of Sciences, New York City; Lederle Laboratories Division, American Cyanamid Company, Pearl River, N. Y.

"The Problem of Staphylococcal Infections" – Walsh McDermott, Cornell University Medical School, New York, N. Y.

"Studies on the Fate of Virulent and Avirulent Staphylococci in Mice" – J. Maclean Smith, State University of Iowa, Iowa City, Iowa.

"Observations on a Chronic Staphylococci in Mice" – Charles A. LeMaistre and T. F. Sellers, Jr. Emory University, Atlanta, Ga.

"The Bloodstream Clearance of Staphylococci in Rabbits" – David E. Rogers, Cornell University Medical College, New York, N. Y.

"Experimental Staphylococcal Infections in the Skin of Man" – Stephen Elek, St. George's Hospital, London, England. (Read by C. H. Lack.)

"The Effect of Antimicrobial Drugs on an Experimental Staphylococcal Infection in Mice" – Robert M. McCune, Jr., P. A. Peter Dineen, and John C. Batten, Cornell University Medical College, New York, N. Y.

BIOLOGIC CHARACTERISTICS OF STAPHYLOCOCCI WHICH MAY RELATE TO VIRULENCE

Session Chairman: Ralph R. Tompsett
Cornell University Medical College, New York, N. Y.

2:00 P.M. –
"Biological Characteristics of Staphylococci Recovered from Pathologic

Materials" – C. H. Lack, Royal National Orthopaedic Hospital, Brockley Hill, Stanmore, Middlesex, England.

"Problems in the Coagulation of Plasma by Staphylocoagulase" – Morris Tager, Emory University, Atlanta, Ga.

"The Effect of Coagulase on the Antibacterial Activity of Normal Human Serum Against Selected Strains of *Micrococcus Pyogenes*" – Richard D. Eckstedt, Northwestern University, Chicago, Ill.

"Studies on Enzyme Formation by Staphylococci" – Howard J. Rogers, National Institute for Medical Research, Mill Hill, London, England. (Read by C. H. Lack.)

"Purification and Chemistry of Staphylococcal Enterotoxin" – Merlin S. Bergdoll, Food Research Institute, University of Chicago, Chicago, Ill.

FRIDAY, FEBRUARY 17, 1956

IMMUNITY, EPIDEMIOLOGY, AND ANTIMICROBIAL RESISTANCE

Session Chairman: David E. Rogers
Cornell University Medical College, New York, N. Y.

9:00 A.M. –
"The Role of Coagulase in Staphylococcal Infections" – Charles H. Rammelkamp, City Hospital, Cleveland, Ohio.

"Bacteriophage Typing of Staphylococci and its Epidemiologic Applications" – John E. Blair, Hospital for Joint Diseases, New York, N. Y.

"Genetics of Antimicrobial Resistance" – Vernon Bryson, National Science Foundation, Washington, D. C.

"Small Colony 'G' Forms of Staphylococci Appearing During Antimicrobial Therapy" – Robert I. Wise, The Jefferson Medical College of Philadelphia, Philadelphia, Pa.

"The Clinical Problem of Antimicrobial Resistant Staphylococci" – Wesley W. Spink, University of Minnesota, Minneapolis, Minn.

CLINICAL STAPHYLOCOCCAL INFECTIONS

Session Chairman: Harry F. Dowling
University of Illinois College of Medicine, Chicago, Ill.

2:00 P.M. –
"The Effect of Present Antimicrobials on Staphylococcal Infections" – Maxwell Finland, Boston City Hospital, Boston, Mass.

Studies on Staphylococci from Hospital Patients" – Vernon Knight and Arthur C. White, Vanderbilt University, Nashville, Tenn.

"Staphylococcal Bacteremia" – Harvey S. Collins, Memorial Hospital, New York, N. Y.

"Staphylococcal Enterocolitis" – William H. Dearing, Mayo Clinic, Rochester, Minn.

"The Unknowns of Staphylococcal Infection" – Rene J. Dubos, Rockefeller Institute for Medical Research, New York, N. Y.

THE CONFERENCE IS DEDICATED TO THE MEMORY OF DOCTOR FRANK N. WILSON

THE ELECTROPHYSIOLOGY OF THE HEART

Thursday, February 16 and
Friday, February 17, 1956

Conference Chairman: Hans H. Hecht
University of Utah, Salt Lake City, Utah

THURSDAY, FEBRUARY 16, 1956

CELLULAR EVENTS DURING THE CARDIAC CYCLE

Session Chairman: K. S. Cole
National Institutes of Health, Bethesda, Md.

9:00 A.M. –
Greetings from the Academy – M. J. Kopac, New York University, Graduate School of Arts and Science, Washington Square College, New York, N. Y.

Greetings from the National Heart Institute – J. Franklin Yeager, National Heart Institute, Bethesda, Md.

The Conference and its Aims – Hans H. Hecht, University of Utah, Salt Lake City, Utah.

"Ionic Transport Across Cell Membranes" – K. S. Cole, National Institutes of Health, Bethesda, Md.

"Resting and Action Potentials of Cardiac Fibers" – S. Weidmann, University of Berne, Berne, Switzerland.

"Quantitative Physical Chemistry of Membranes" – H. Eyring, University of Utah, Salt Lake City, Utah.

Discussion: Wm. L. Nastuk, Columbia University, New York, N. Y.

"Abnormal Cardiac Transmembrane Potential, Preliminary Comments" – Hans H. Hecht, University of Utah, Salt Lake City, Utah.

Discussion: Ch. E. Kossmann, New York University, New York, N. Y.

SPREAD OF IMPULSE THROUGH CARDIAC MUSCLE

Session Chairman: H. B. Burchell
Mayo Clinic, Rochester, Minn.

2:00 P.M. –
"The Problem of Current Concepts of Excitation" – H. B. Burchell, Mayo Clinic, Rochester, Minn.

"The General Order of Excitation and Recovery" – H. Schaefer, University of Heidelberg, Heidelberg, Germany.

"Excitation of Ventricular Musculature I" – A. M. Scher, University of Washington, Seattle, Wash.

"Excitation of Ventricular Musculature II" – D. Durrer, Amsterdam, Holland.

"Excitation of Ventricular Musculature III" – D. Sodi-Pallares, National Heart Institute, Mexico City, Mexico.

"Further Comments on Excitation and Recovery of Ventricular Musculature" – M. Prinzmetal, Cedars of Lebanon Hospital, Los Angeles, Calif.

Discussion: E. Lepeschkin, University of Vermont, Burlington, Vt.

Panel: Anomalous Atrio-ventricular Excitation."
Moderator: Hans H. Hecht, Salt Lake City, Utah.
M. Prinzmetal, Los Angeles, Calif.
F. F. Rosenbaum, Milwaukee, Wis.
D. Sodi-Pallares, Mexico City, Mexico.
L. Wolff, Boston, Mass.

CARDIAC RECOVERY

Session Chairman: Ch. E. Kossmann
New York University, New York, N. Y.

8:00 P.M. –
"Recovery of Cardiac Muscle, a Particular Problem" – Ch. E. Kossmann, New York University, New York, N. Y.

"The Area of the Electrocardiogram and the Ventricular Gradient" – M. Gardberg, Louisiana State University, New Orleans, La.

"The Integrated Electrocardiogram" – S. Briller, New York University, New York, N. Y.

Discussion: O. Schmitt, University of Minnesota, Minneapolis, Minn.

Panel: "The U-wave and After Potential in Cardiac Muscle."
Moderator: E. Lepeschkin, Burlington, Vt.
L. N. Katz, Chicago, Ill.
H. Schaefer, Heidelberg, Germany.
A. M. Shanes, Washington, D. C.
S. Weidmann, Berne, Switzerland.

FRIDAY, FEBRUARY 17, 1956

DISTRIBUTION OF ELECTRICAL POTENTIALS IN VOLUME CONDUCTORS

Session Chairman: L. N. Katz
Michael Reese Hospital, Chicago, Ill.

9:00 A.M. –

"The Physiologic Basis of Spread of Cardiac Action Currents Through the Body" – L. N. Katz, Michael Reese Hospital, Chicago, Ill.

"Spread of Current in Homogeneous Volume Conductors" – F. D. Johnston, University of Michigan, Ann Arbor, Mich.

"Spread of Currents in Volume Conductors of Finite Extent" – E. Frank, University of Pennsylvania, Philadelphia, Pa.

Discussion: D. A. Brody, University of Tennessee, Memphis, Tenn.

"Conductivity of Living Tissues" – H. Schwan, University of Pennsylvania, Philadelphia, Pa.

"The Effect of Finite Boundaries and in Homogeneous Areas in Surface Leads" – C. V. Nelson, University of Utah, Salt Lake City, Utah.

Discussion: C. F. Kay, University of Pennsylvania, Philadelphia, Pa.
H. C. Burger, University of Utrecht, Utrecht, Holland.

ANALYSIS OF THE SURFACE ELECTROCARDIOGRAM

Session Chairman: G. E. Burch
Tulane University, New Orleans, La.

2:00 P.M. –

"Experimental and Theoretical Vector Analysis" – G. E. Burch, Tulane University, New Orleans, La.

"Lead Vector Projections I" – H. C. Burger, University of Utrecht, Utrecht, Holland.

"Lead Vector Projections II" – Ch. E. Kossmann, New York University, New York, N. Y.

Discussion: E. Newmann, University of Tennessee, Nashville, Tenn.

"Lead Vectors and Transfer Impedance" – O. Schmitt, University of Minnesota, Minneapolis, Minn.

"Exploratory Lead Systems and 'Zero Potentials' " – R. Bayley, University of Oklahoma, Oklahoma City, Okla.

Discussion: H. C. Burger, University of Utrecht, Utrecht, Holland
L. N. Katz, Michael Reese Hospital, Chicago, Ill.

8:15 P.M. –
Roundtable Discussion: "Electrocardiographic Theory and Practice."
Open to all participants of the Conference.

NEW MEMBERS

Elected February 23, 1956

LIFE MEMBERSHIP

Manger, William Muir, M.D., Hypertension. Fellowship, Internal Medicine, Mayo Foundation, Rochester, Minn.

Nataro, Maurice, M.D., Internal Medicine. Chief, Radioisotope Service, Veterans Administration Hospital, Louisville, Ky.

SUSTAINING MEMBERSHIP

Adolph, William E., M.D., Radiology. Radiologist, Encino, Calif.

Baltzan, D.M., M.D., Biology. Private Practice, Saskatoon, Sask., Canada.

Blackwell, Samuel J., M.D., Medicine. Private Practice, Memphis, Tenn.

Buchner, Edward Franklin, III, M.D., Internal Medicine. 1st Year Resident, St. Louis City Hospital, St. Louis, Mo.

Donovan, Maurice Anthony, M.D., Cardiovascular Diseases. Private Practice, Schenectady, N. Y.

Duchesne, Edward Ronald, F.R.C.S., Cardiovascular Research. Head, Thoracic Surgical Research Laboratory, Emory University, Emory University, Ga.

Eckert, Walter L., M.D., Biology. Medical Director, The Adams Company, Philadelphia, Pa.

Fleischer, Harry, M.D., Surgery, Oceanography. Private Practice, New York, N. Y.

Freckman, Herman A., M.D., Cancer. Private Practice, Cincinnati, Ohio.

Green, Henry, M.D., Medicine. Private Practice, Maplewood, N. J.

Lindberg, Olov, Ph.D., Cytology. Chief. Experimental Biology, Wenner-Gren Institute, Stockholm, Sweden.

Tyson, William G., M.D., Medicine. Private Practice, Savannah, Ga.

Ziman, Edmund, M.D., Psychiatry. Private Practice, New York, N. Y.

Zion, David E., M.D., Gastrointestinal Tract. Director, Diagnostic Radiology, Cedars of Lebanon Hospital, Los Angeles, Calif.

ACTIVE MEMBERSHIP

Adams, Vincent J., M.D., Internal Medicine. Assistant Attending, Wyckoff Heights Hospital, Brooklyn, N. Y.

Alexander, France, M.D., Cardiovascular Disease. Sr. Medical Resident, Presbyterian Hospital, Chicago, Ill.

Alpar, Saffet Riza, Dr. Rer. Nat. Industrial Chemistry. Professor, Istanbul University, Istanbul, Turkey.

Alvarez, Manuel, Jr., Tectonics, Geology. Instituto Nacional de la Investigacion Cientifica, Mexico, D.F., Mexico.

Andrews, John S., Jr., Ph.D., Biochemistry. Junior Research Physiological Chemist, University of California, Los Angeles, Calif.

Antrobus, Edmund S.A., Ph.D., Geology. Geologist, Anglo-American Corporation of South Africa Ltd., Johannesburg, South Africa.

Axelrad, Arthur Aaron, Ph.D., Cancer. Research Fellow, National Cancer Institute of Canada, Montreal, P.Q., Canada.

Babb, M. Virginia, B.S., Bacteriology. Research Scientist, Wyeth Institute for Medical Research, Philadelphia, Pa.

Babcock, Virginia Iving, B.A., Virology. Research Assistant, Sloan-Kettering Institute, New York, N. Y.

Bachelis, Elizabeth, B.A., Medical Bacteriology. Senior Bacteriologist, Fordham Hospital, New York, N. Y.

Baker, Gladys Elizabeth, Ph.D., Mycology. Professor, Chairman, Plant Science Department, Vassar College, Poughkeepsie, N. Y.

Barrett, Alex Keith, B.S., Pediatric Allergy. Research Fellow, New York Medical College, New York, N. Y.

Barth, Rolf F., Immunochemistry. Cornell University, Ithaca, N. Y.
Bauer, John D., M.D., Pathology. Director, Laboratories, De Paul Hospital, St. Louis, Mo.
Baum, William Stanhope, M.D., Internal Medicine. Assistant Director, National Cancer Institute, Bethesda, Md.
Behr, Donald J., M.D., Medicine. Resident, Medicine, Kings County Hospital, Brooklyn, N. Y.
Bell, Grace B., D.O., Biochemistry. Executive, Department, Biochemistry, College of Osteopathic Physicians and Surgeons, Los Angeles, Calif.
Berggren, Helge, Ph.D., Dental Research. Director, Eastman Dental Institute, Stockholm, Sweden.
Bemstein, Martin, M.D., Ophthalmology. Postgraduate Student, Harvard Medical School, Resident Physician, Ophthalmology, Veterans Administration Hospital, Bronx, New York, N. Y.
Biesiot, Peter Gerard, Jr., M.S., Geology. Paleontologist, Standard-Vacuum Petroleum, Maatschappij, Palembang, Sumatra, Indonesia.
Blagdon, Joseph Charles, M.D., Biology, Psychology. Physician, Hopkins Clinic, Cleveland, Ohio.
Bliven, Floyd Edward, Jr., M.D., Orthopedic Surgery. Instructor, Orthopedic Surgery, University of Rochester, Rochester, N. Y.
Block, Arnold S., M.D., Psychiatry. Psychiatrist, St. Louis, Mo.
Block, James D., Ph.D., Psychology. Research Fellow, U.S. Public Health Service, Division of Mental Health, Ithaca, N. Y.
Block, Stanley L., M.D., Psychiatry. Instructor, University of Cincinnati, Cincinnati, Ohio.
Booker, Walter M., Ph.D., Pharmacology. Head, Professor, Department, Pharmacology, Howard University, Washington, D.C.
Bookmyer, Robert M., M.D., Biology. U.S. Naval Hospital, Key West, Fla.
Borland, John R., Ph.D., Biology. Editor of Publications, Physicians Publications Inc., New York, N. Y.
Boyle, Grace W., B.A., Pharmacology. Junior Pharmacologist, New York, N. Y.
Braunlin, Edgar L., M.D., Psychiatry. Medical Director, Dartmouth Hospital, Dayton, Ohio.
Bremer, Elvin M., M.D., Cardiology. Clinical Instructor, Internal Medicine, Marquette University, Milwaukee, Wis.
Brignon, Jean J., Dr. Pharm., Biological Chemistry. Nancy, France.
Brock, Thomas D., Ph.D., Microbiology. The Upjohn Co., Kalamazoo, Mich.
Brody, Daniel A., M.D., Electrophysiology. Associate Professor, University of Tennessee, Memphis, Tenn.
Brown, H. Campbell, M.D., Anthropology. Private Practice, Vernon, B.C., Canada.
Bruni, Carlo, M.D., Connective Tissues. Fellow, Cancer Research, Washington University, St. Louis, Mo.
Brusch, Charles A., M.D., Geriatrics. Director, Brusch Medical Center, Cambridge, Mass.
Buchanan, J. Robert, M.D., Endocrinology. Assistant Resident, Physician, The New York Hospital, New York, N. Y.
Buchman, Myron I., M.D., Obstetrics. Instructor, Cornell University School of Medicine, New York, N. Y.
Burke, James C., M.S., Research. Chief, Parasitic Disease Section, Walter Reed Army Medical Center, Washington, D.C.
Burkland, Carl Edwin, M.D., Urology. Attending Urologist, Sutter Hospital, Sacramento, Calif.
Burnham, Preston J., M.D., Surgery. Private Practice, Salt Lake City, Utah.
Burns, W. Thomas, M.D., Biology. Private Practice, Harrisburg, Pa.
Cafruny, Edward J., Ph.D., Pharmacology. Instructor, Pharmacology, University of Michigan, Ann Arbor, Mich.
Campana, Hernan A., M.D., Pathology, Biology. Resident, Bender Hygienic Laboratory, Albany, N. Y.
Cantrell, Frank Peironnet, M.D., Internal Medicine. Chief Resident, Veterans Administration Hospital, Atlanta, Ga.
Carden, George A., Jr., M.D., Biology. Private Practice, New York, N. Y.
Carlson, William S., D.Sc., Science. President, State University of New York, Albany, N. Y.

Carnell, Paul H., Ph.D., Chemistry. Chairman, Department, Chemistry, Albion College, Albion, Mich.
Carrasco, Félix de Jesús G., M.D., Medicine. Surgeon, Municipal Hospital, Coamo, Puerto Rico.
Carter, James William, Jr., M.D., Obstetrics. Private Practice, San Antonio, Texas.
Cassels, Donald E., M.D., Medicine. Professor, Pediatrics, University of Chicago, Chicago, Ill.
Chambers, Edward L., M.D., Cell Physiology. Assistant Professor, Physiology, University of Miami, Coral Gables, Fla.
Chang, Gilbert C. H., Ph.D., Virology. Assistant Professor, Microbiology, University of Wisconsin, Madison, Wis.
Chinn, Austin B., M.D., Biology. The Benjamin Rose Hospital, Cleveland, Ohio.
Christhilf, Stuart M., M.D., Biology. Private Practice, Annapolis, Md.
Christiaens, Robert J., M.D., Biology. Senior Physician, State Hospital, Taunton, Mass.
Christian, John J., M.D., Internal Medicine. Clinical Consultant, Department, Medicine, Scott and White Clinic, Temple, Texas.
Church, Aloysius S., M.D., Psychiatry. Assistant Medical Superintendent, St. Joseph's Retreat, Dearborn, Mich.
Chutkow, Lee R., M.D., Biology. Strong Memorial Hospital, Rochester, N. Y.
Clayton, Charles C., Ph.D., Biochemistry. Assistant Professor, Biochemistry, Medical College of Virginia, Richmond, Va.
Clemens, Kurt J., B.A., Pharmaceuticals. Technical Assistant to Medical Director, J.B. Roerig and Co., Chicago, Ill.
Cohen, Barbara Keil, M.D., Oceanography, Washington, D.C.
Conrad, Carl C., M.D., Biology. Cambridge City Hospital, Cambridge, Mass.
Cordeau, J. P., M.D., Neurophysiology. Instructor, University of Montreal, Montreal, P.Q., Canada.
Courchene, John E., M.S., Biology. Instructor, Seattle University, Seattle, Wash.
Crocker, Diane Winston, M.D., Biology. Research Fellow, Los Angeles Childrens Hospital, Los Angeles, Calif.
Dacanay-Martinez, Febe, M.D., Obstetrics, Gynecology. Resident Physician, South Shore Hospital, Chicago, Ill.
Danforth, William, Ph.D., Zoology. Assistant Professor, Biology, Illinois Institute of Technology, Chicago, Ill.
D'Angelo, George J., M.D., Cardiovascular Surgery. Instructor, Surgery, Duke Hospital, Durham, N.C.
Davis, Frank W., Jr., M.D., Biology. Private Practice, Baltimore, Md.
Davis, Joseph H., M.D., Forensic Pathology. Instructor, Louisiana State University, New Orleans, La.
De Almeida, Ary Lopes, M.D., Gastroenterology. Assistant, Medical Clinic, University of São Paulo, São Paulo, Brazil.
Del Prado, José, M.D., Biology. Private Practice, Ponce, Puerto Rico.
DeNisco, Stanley G., M.A., Chemistry, Nutrition. Assistant Vice President, Department, Science, Ted Bates and Company Inc., New York, N. Y.
Di Sant'Agnese, Paul A., M.D., Pediatrics. Assistant Professor, Columbia University, New York, N. Y.
Dowling, James Thomas, M.D., Endocrinology. Research Fellow, Medicine, Harvard Medical School, Boston, Mass.
Dreiling, David A., M.D., Surgery. Assistant Attending Surgeon, Mt. Sinai Hospital, New York, N. Y.
Drenning, Paul T., M.D., Internal Medicine. Private Practice, Memphis, Tenn.
Driscoll, Anne Catherine, M.D., Medicine. Resident, Internal Medicine, New England Center Hospital, Boston, Mass.
Dube, Arthur H., M.D., Endocrinology. Clinical Instructor, State University of New York, N. Y.
Duff, Raymond S., M.D., Public Health, Director, Medical Services, New Haven Department of Health, New Haven, Conn.
Dunne, Thomas B., M.D., Preventive Medicine. Captain, U.S. Army Medical Corps, Walter Reed Hospital, Washington, D.C.
Dutta-Choudhuri, Rebati K., M.B., Tumor Pathology. Post Graduate Lecturer, Pathology, Chittaranjan Cancer Hospital, Calcutta, India.

Duvall, George Evered, Physics. Assistant Director, Poulter Laboratory Division, Stanford Research Institute, Menlo Park, Calif.
Edwards, Edward A., M.D., Biology. Private Practice, Boston, Mass.
Eissler, K. R., M.D., Biology. Private Practice, New York, N. Y.
Epsten, R. M., D.O., Medicine. Private Practice, San Diego, Calif.
Feeley, Edward J., Ph.D., Cytology. Instructor, St. John's University, Brooklyn, N. Y.
Feigin, Irwin H., M.D., Neuropathology. Attending Pathologist, Mt. Sinai Hospital, New York, N. Y.
Feldman, Donald, M.D., Microbiology. 1st. Lt., U. S. Army Medical Corps, U. S. Army Hospital, Fort Rucker, Ala.
Felts, William J. L., Ph.D., Anatomy. Assistant Professor, The Medical School, University of Minnesota, Minneapolis, Minn.
Ferguson, John A., M.D., Neuropathology. Director, Laboratories and Research, Dayton State Hospital, Dayton, Ohio.
Finkenstaedt, John Turner, M.D., Physics, Chemistry, Biology. Assistant Professor, Biochemistry, Medicine, Yale University, New Haven, Conn.
Finlay, John M., M.D., Bone and Calcium Metabolism. Senior Fellow, Medical Research Council of Canada, Toronto, Ont., Canada.
Fisher, Myron W., Ph.D., Microbial Infection. Group Leader, Microbiological Research, Parke, Davis and Company, Detroit, Mich.
Fisher, Thelma N., Ph.D., Microbiology. Research Associate, Microbiology, Western Reserve University, Cleveland, Ohio.
Fister, George M., M.D., Physiology of the Kidney. Urologist, Ogden, Utah.
Flavin, Martin, Ph.D., Biochemistry. Fellow, New York University Medical School, New York, N. Y.
Foley, Gertrude, Chemistry. Chemistry Laboratory Technician, St. Barnabas Hospital, New York, N. Y.
Foster, Frank P., M.D., Internal Medicine. Physician, Lahey Clinic, Boston, Mass.
Fountain, Freeman P., M.D., Physical Medicine. Senior Resident, Physical Medicine, University of Colorado, Denver, Colo.
Fowler, Noble Owen, M.D., Medicine. Associate Professor, Cardiovascular Research, School of Medicine, Emory University, Atlanta, Ga.
Fraenkel-Conrat, Heinz L., Ph.D., Biochemistry. Associate Research Biochemist, Virus Laboratory, University of California, Berkeley, Calif.
Frank, Irwin N., M.D., Exfoliative Cytology. Cytologist, Strong Memorial Hospital, Rochester, N. Y.
Frankel, Walter K., M.D., Urology. Medical Officer, U. S. Army Ordnance Corps, Picatinny Arsenal, Dover, N. J.
Frappier, Armand, M.D., Tuberculosis. Dean, School of Hygiene, University of Montreal, Montreal, P.Q., Canada.
Friedhoff, Arnold J., M.D., Experimental Psychiatry. Staff Psychiatrist, Bellevue Hospital, New York, N. Y.
Friend, Dale Gilbert, M.D., Biology. Senior Associate Medicine, Peter Bent Brigham Hospital, Boston, Mass.
Fry, Dinah E., M.A., Psychology. Research, Caldwell, N. J.
Fuller, George Ripley, M.D., Neurophysiology. Research Anatomist, University of California, Los Angeles, Calif.
Furlenmeier, Andreas E., Ph.D., Chemistry. Research Associate, University of Pittsburgh, Pittsburgh, Pa.
Gahwyler, Max, M.D., Biology. Assistant Medical Service Director, Pfizer International, New York, N. Y.
Gavan, Thomas L., M.D., Pathology. Resident, Department, Pathology, Cleveland City Hospital, Cleveland, Ohio.
Gebauer, Franz, Dr. Eng. Engineering. Vienna, Austria.
Gerisch, Robert A., M.D., Cardiology. Head, Department, Cardiology, U.S. Naval Hospital, Chelsea, Mass.
Gilman, Edward N., Ph.D., Virology. Bacteriologist, Fort Detrick, Frederick, Md.
Gittler, Robert Dore, M.D., Endocrinology. Instructor, Medicine, University of Michigan, Ann Arbor, Mich.
Glashow, Jules Lewis, M.D., Otology. Instructor, Ear, Nose, Throat, New York Medical College, New York, N. Y.

Goalwin, Alta Tresa, M.D., Pediatrics. Clinical Instructor, Pediatrics, New York Medical College, New York, N. Y.

Godechot, Roger, M.D., Dermatology. Associated Pathology Laboratory, Hospital Boucicant, Paris, France.

Godfrey, Lincoln Jr., Internal Medicine. Associate Medicine, University of Pennsylvania, Philadelphia, Pa.

Gold, Harold, M.D., Morbid Anatomy. Assistant Director, Department, Laboratories, Mt. Sinai Hospital, Cleveland, Ohio.

Golden, Alfred, M.D., Medicine. Assistant Professor, Pathology, Wayne University, Detroit, Mich.

Goldner, J. Leonard, M.D., Orthopedic Surgery. Associate Professor, Duke University, Durham, N.C.

Goodman, James J., M.D., Psychiatry. Private Practice, Miami, Fla.

Gordon, Harry William, Ph.D., Biochemistry. Colgate Palmolive Company, Jersey City, N. J.

Green, Maurice R., M.D., Psychiatry. Associate Attending Psychiatrist, Roosevelt Hospital, New York, N. Y.

Gylfe, Julina, M.D., Neurology. Private Practice, Norristown, Pa.

Haas, Marczel, M.D., Surgery. Assistant Attending, Sydenham Hospital, New York, N. Y.

Hadley, W. Keith, B.A., Microbiology. Student, Yale University, New Haven, Conn.

Hardy, Lawrence B., B.A., Genetics. Scientific Aide, Biological Station, Roswell Park Memorial Institute, Springville, N. Y.

Harmel, Merel H., M.D., Physiology. Professor, Chairman, Department, Anesthesiology, State University of New York, Brooklyn, N. Y.

Hases, Ruth, B.A., Bacteriology. Bacteriologist, Bellevue Hospital, New York, N. Y.

Held, J. R., D.V.M., Public Health. Assistant Veterinarian, State Board of Health, Jacksonville, Fla.

Helm, Robert A., M.D., Cardiovascular Disease. Assistant Professor, Medicine, University of Cincinnati, Cincinnati, Ohio.

Herbsman, Horace, M.D., Surgery. Senior Assistant Surgeon, U.S. Public Health Service, National Cancer Institute, Bethesda, Md.

Herring, L. D., D.D.S., Dentistry. Private Practice, Dentist, Raleigh, N.C.

Hirsch, Robert, M.D., Psychiatry. Resident Psychiatrist, V.A., Bellevue Hospital, New York, N. Y.

Holter, Norman J., M.A., Medical Physics. President, Holter Research Foundation Inc., Helena, Mont.

Hoptman, Julian, D.Sc., Ecology of Disease. Research Consultant, U.S. Govemment, Washington, D.C.

Hungerford, Gerald F., Ph.D., Anatomy. Assistant Professor, Washington, D.C.

Ingraham, Joseph Sterling, Ph.D., Biochemistry. Assistant Professor, Microbiology, Indiana University Medical Center, Indianapolis, Ind.

Innella, Filomena P., B.A., Immunology. Immunologist, First Army Area Medical Laboratory, New York, N. Y.

Itkin, Irving H., M.D., Allergy. Clinical Assistant, Medicine, Massachusetts General Hospital, Boston, Mass.

Jackson, Paul P , M.D., Surgery. Private Practice, Vancouver, B.C., Canada.

Jackson, Robert Henry, M.D., General Surgery. Resident, Surgery, Lutheran Hospital, Cleveland, Ohio.

Jacobs, Walter H., M.D., Medicine. Resident, Kings County Hospital, Brooklyn, N. Y.

Jaffee, Isadore H., M.D., Internal Medicine. Associate Visiting Physician, Boston City Hospital, Boston, Mass.

Janeway, Charles A., M.D., Pediatrics. Thomas Morgan Rotch Professor, Pediatrics, Harvard Medical School, Boston, Mass.

Janiger, Oscar, D.O., Physiology. Professor, Psychiatry, College of Osteopathic Physicians and Surgeons, Los Angeles, Calif.

Jensen, Roderick E., B.A., Physiology. Teaching Assistant, Physiology Department, University of California, Los Angeles, Calif.

Karr, Norman W., M.D., Pharmacology. Assistant Director, Research, Squibb Institute for Medical Research, New Brunswick, N. J.

Karzon, David T., M.D., Virology. Assistant Professor, Pediatrics, University of Buffalo, Buffalo, N. Y.

Katcher, Naomi, M.D., Psychiatry. Private Practice, New York, N. Y.

Kelly, Keith H., M.D., Clinical Oncology. Assistant Director, Hospital for Tumors and Allied Diseases, City of Hope Medical Center, Duarte, Calif.

Klein, Robert Louis, M.A., Biochemistry. Associate Scientist, Schering Corporation, Bloomfield, N. J.

Konig, Otto, Ph.D., Chemistry. Research Chemist, National Lead Company, Brooklyn, N. Y.

Koo, Kook Hwae, M.D., Human Cancer. Chief Faculty, Professor, Pathology, Seoul Women's Medical College, Seoul, Korea.

Krause, Ralph A., B.S., Electronics. Associate Director, Stanford Research Institute, Menlo Park, Calif.

Kutsunai, Toshio, M.D., Medicine. Attending Staff, Hilo Memorial Hospital, Hilo, Hawaii.

Lambert, Francis L., M.S., Invertebrate Physiology. Instructor, Biology, Union College, Schenectady, N. Y.

Lautsch, Willy P. G., Dipl. Ing., Organic Chemistry. Director, Institute for Organic Chemistry, Free University of Berlin, Berlin, Germany.

Legg, James S., M.S., Microbiology. Technical Supervisor, Human Bios Production, Cutter Laboratories, Berkeley, Calif.

Levine, Herbert Jerome, M.D., Internal Medicine. Clinical Associate, National Cancer Institute, Bethesda, Md.

Lewi, Sam, M.D., Serology. Chief, Laboratory, Centre National de Transfusion Sanguine, Paris, France.

Linsenmann, Karl W., M.D., General Science. Private Practice, Medicine, Surgery, Midland, Mich.

Love, Julian, M.D., Internal Medicine. Commanding Officer, U.S. Naval Hospital, Corona, Calif.

Lynn, Ralph Beverley, M.D., Surgical Physiology. Assistant Professor, Surgery, University Hospital, Saskatoon, Sask., Canada.

McIntosh, Wayne Thol, B.S., Nuclear. Engineer, Controls Group, Nuclear Division, Glenn L. Martin Company, Baltimore, Md.

McQuown, Albert L., M.D., Pathology. Pathologist, Our Lady of the Lake Hospital, Baton Rouge, La.

Magee, Lyman A., M.S., Bacteriology. Graduate Assistant, Bacteriology, Louisiana State University, Baton Rouge, La.

Manson, Frank E., B.S., Neuropsychiatrics. Physical Science Aide, U.S. Veterans Hospital, Coatesville, Pa.

Mather, Alan, Ph.D., Physiological Chemistry. Research and Clinical Biochemist, The Memorial Hospital, Wilmington, Del.

Massumi, Rashid A., M.D., Cardiovascular Disease. Research Fellow, Los Angeles County Heart Association, Los Angeles, Calif.

Miller, Jack W., Ph.D., Pharmacology. Instructor, University of Wisconsin, Madison, Wis.

Mitchell, Daniel Avery, Jr., M.D., Surgery. Resident, Surgery, Roswell Park Memorial Institute, Buffalo, N. Y.

Monroe, Robert A., Ph.D., Physiology. Chief, Fission Product Metabolism Section, University of California Atomic Energy Project, Los Angeles, Calif.

Moon, Henry D., M.D., Endocrinology. Associate Professor, Pathology, University of California, School of Medicine, San Francisco, Calif.

Mukaibo, Takashi, Ph.D., Chemistry, Physics. Scientific Attaché, Embassy of Japan, Washington, D.C.

Nash, Joe B., Ph.D., Pharmacology. Assistant Professor, University of Texas, Galveston, Texas.

Noble, Thomas B., M.D., Anthropology. Surgeon, Consultant to Arizona Commission on Indian Affairs, Indianapolis, Ind.

Nurnberger, John L., M.D., Psychiatry. Chairman, Department, Psychiatry, Indiana University, Indianapolis, Ind.

Nye, Robert E., Jr., M.D., Cardiopulmonary Diseases. Instructor, Medicine, University of Rochester, Rochester, N. Y.

Oppenheimer, Edward H., Astronomy, Plastics. President, Oppenheimer Casing Company, Chicago, Ill.

Orringer, David, M.D., Medicine. Instructor, Anatomy, University of Pittsburgh, Pittsburgh, Pa.
Osserman, Kermit E., M.D., Internal Medicine. Assistant Attending Physician, Myasthenia Gravis Clinic, New York, N. Y.
Parlow, Albert F., B.A., Endocrinology. Graduate Student, Princeton University, Princeton, N.J.
Pipberger, Hubert V., M.D., Cardiology. Research Fellow, Institute for Medical Research, Cedars of Lebanon Hospital, Los Angeles, Calif.
Putnam, Richard C., M.D., Medicine. Fellow, Chemotherapy, Memorial Hospital, New York, N. Y.
Rall, David P., Ph.D., Pharmacology. Pharmacologist, National Cancer Institute, Bethesda, Md.
Reddick, Mary Logan, Ph.D., Neuroembryology. Chairman, Department, Biology, Atlanta University, Atlanta, Ga.
Redin, Gunnar S., B.S., Biology. Biologist, American Cyanamid Company, Pearl River, N. Y.
Riklin, Bernard M., D.D.S., Biology. Private Practice, New York, N. Y.
Rothburd, Charles M., M.D., Internal Medicine. Instructor, Gastroenterology, New York Polyclinic Hospital, New York, N. Y.
Ruhstaller, Frank David, M.D., Bacteriology. Private Practice, Stockton, Calif.
Rutgers, Jay G., Ph.D., Analytical Chemistry. Research Associate, Ambler, Pa.
Sabine, Jean C., M.D., Medicine. Staff Member, Medical Research, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico.
Saliger, Rudolf, Dr. Eng., Civil Engineering. President, Dean, Technology, University of Vienna, Vienna, Austria.
Sawyer, Philip N., M.D., Physiology. Assistant Instructor, Surgery, Hospital of the University of Pennsylvania, Philadelphia, Pa.
Schiller, Ralph, Ph.D., Physics. Assistant Professor, Stevens Institute, Hoboken, N. J.
Schlein, Abraham, B.S., Cell Physiology. Graduate Student, New York University, New York, N. Y.
Schreiner, Bernard F., Jr., M.D., Internal Medicine. Trainee, National Institute of Health, Strong Memorial Hospital, Rochester, N. Y.
Severinghaus, John W., M.D., Physiology. Senior Assistant Surgeon, Clinical Center, National Institutes of Health, Bethesda, Md.
Shively, John Adrian, M.D., Clinical Pathology. Clinical Pathologist, Indianapolis General Hospital, Indianapolis, Ind.
Siegrist, J. C., D.V.M., Veterinary Medicine. Head, Department, Veterinary Medicine, Schering Corp., Bloomfield, N. J.
Silverman, Marvin J., D.V.M., Pharmacy. Instructor, Pharmacy, University of Pennsylvania, Philadelphia, Pa.
Silvetti, Anthony N., M.D., Skin Grafting. Experimental Surgery, Naval Medical Research Institute, Bethesda, Md.
Sjögren, Bertil, M.D., Drugs, Biologicals. Director, Research and Development, AB Astra, Södertälje, Sweden.
Smyrd, Edwin S., D.D.S., Astronomy, Physics. Private Practice, Detroit, Mich.
Spencer, George N., M.D., Cardiology. Section Chief, Medical Service, V.A. Center, Wood, Wis.
Splendido, Joseph A., M.D., Medicine. Instructor, Medicine, University of Pennsylvania, Philadelphia, Pa.
Stanley, Robert R., M.D., Biology. Private Practice, Greenville, S.C.
Strang, Ruth H., M.D., Pediatrics. Assistant Professor, Department, Bacteriology, New York Medical College, New York, N. Y.
Stranski, Iwan N., Ph.D., Physical Chemistry. Professor, Director, Institute of Physical Chemistry, Technical University, Berlin, Germany.
Sutow, Wataru W., M.D., Cancer. Associate Pediatrician, University of Texas, Houston, Texas.
Swarth, Oscar S., Ph.G., Medicine. Medical Research Representative, Geigy Pharmaceuticals, New York, N. Y.
Sweeney, William M., M.D., Internal Medicine. Professional Service Department, Lederle Laboratories Division, American Cyanamid Company, Pearl River, N. Y.
Tackler, Barry, D.D.S., Dentistry. Dentist, New York, N. Y.

Tanzola, Joseph V., B.S., Microbiology. Bacteriologist, (CIBA) Pharmaceuticals, Summit, N. J.
Taylor, John Langdon, Jr., Ph.B., Neurophysiology. Graduate Student, Los Angeles, Calif.
Tedeschi, David H., Ph.D., Neuropharmacology. Senior Scientific Worker, Smith, Kline and French Laboratories, Philadelphia, Pa.
Tombridge, Thomas Leo, M.D., Pathology. Fellow, Department, Pathology, St. Louis University, St. Louis, Mo.
Towe, Arnold L., Ph.D., Neurophysiology. Instructor, Anatomy, University of Washington, Seattle, Wash.
Tschen, Eduardo, A., M.D., Pediatric Allergy. Research Fellow, Pediatric Allergy, New York Medical College, New York, N. Y.
Twarog, Betty Mack, Ph.D., Biology. Research Fellow, Harvard University, Boston, Mass.
Urteaga, Oscar, M.D., Pathology. Hospital 2 de Mayo, Lima, Peru.
Usano, Manuel, M.D., Biology. Pfizer International Co., Inc., New York, N.Y.
Vavra, James J., Ph.D., Biochemistry. Research Biochemist, The Upjohn Company, Kalamazoo, Mich.
Veneziano, Philip P., M.S., Experimental Embryology. Research Associate, Biological Sciences, Northwestern University, Evanston, Ill.
Vitolo, Ralph Erminio, M.D., Surgery. Assistant Chief, Surgery, Veterans Administration Hospital, Fayetteville, N.C.
Vlasto, George S., B.A., Biology. Laboratory Technician, Washington Square College, New York University, New York, N. Y.
Vogel, Henry, M.S., Bacteriology. Senior Bacteriologist, New York City Department of Health, New York, N. Y.
Vogt, Walter W., M.D., Psychiatry. Psychiatrist, Beacon, N. Y.
von Werssowetz, Odon F., M.D., Rehabilitation. Medical Director, Gonzales Warm Springs Foundation, Gonzales, Texas.
Wade, Edward A., Ph.D., Psychology. Research Associate, Biomechanics Laboratory, Tufts University, Medford, Mass.
Weaver, Davis C., M.D., Medicine. Fellow, New York Heart Association, St. Lukes Hospital, New York, N. Y.
Wieder, Samuel, M.A., Biology. Assistant, Medical Director, Wyeth Laboratories, Philadelphia, Pa.
Wiener, Frank Philip, M.A., Virology. Research Associate, Sharp and Dohme Inc., Philadelphia, Pa.
Yalim, Zeki Ragip, M.D., Biology. Professor, Hygiene, University of Istanbul, Istanbul, Turkey.
Yarbro, Claude L., Ph.D., Biochemistry. Instructor, University of North Carolina, Chapel Hill, N.C.
Yedvab, Jay Okun, B.A., Medicine. Student, Alfred University, Alfred, N.Y.
Zeedick, John Francis, M.D., Anesthesiology. Resident, Mercy Hospital, Pittsburgh, Pa.
Zenewitz, Joseph A., B.S., Physics, Chemistry. Chemist, Dental Research Section, Walter Reed Army Institute of Research, Washington, D.C.
Zike, Kenneth, M.D., Biology. Childrens Hospital Society of Los Angeles, Los Angeles, Calif.
Zinterhofer, John, M.D., Physiology. Private Practice, Detroit, Mich.
Zullo, Robert J., M.D., Medicine. Private Practice, New Brunswick, N. J.

STUDENT MEMBERSHIP

Campbell, Edwin Alexander, Medical Science. Student, New York University Post Graduate School of Medicine, New York, N. Y.
Crisini, John, Psychology. Student, Columbia University, New York, N. Y.
Levine, Joseph S., M.S., Physiology. Student, Albert Einstein College of Medicine, New York, N. Y.